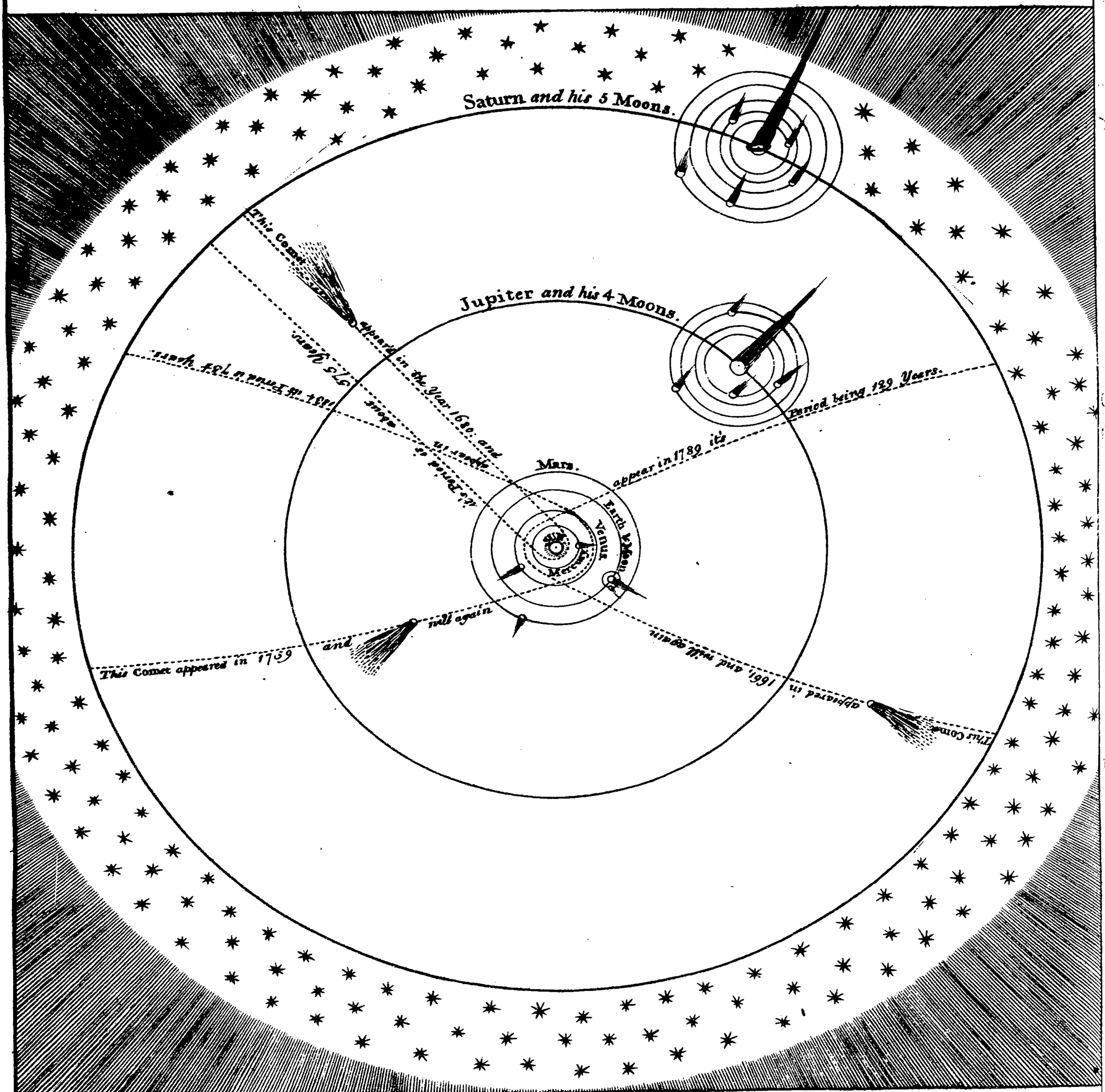
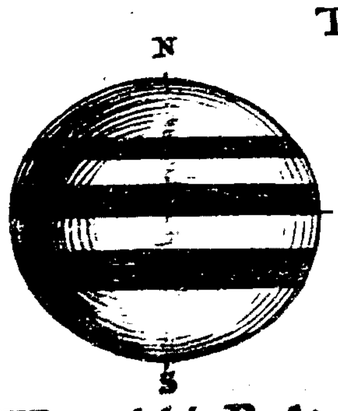
The COPERNICAN or TRUE SYSTEM of the UNIVERSE:

exhibiting the **Orbits** *of the* **PLANETS** *according to their mean* **Distances** *from the* **SUN.**



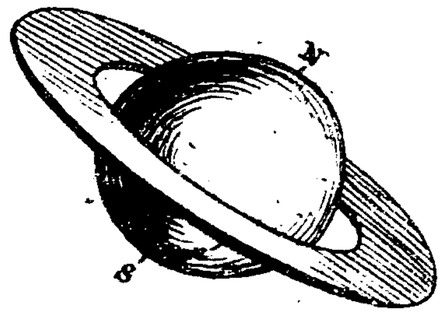
The **PLANETS** *in Proportion to* each other *with the Inclinations of their Axes, &c.*



JUPITER *and his* **Belts.**

MARS. **EARTH.** **VENUS.** **MERCURY.**

MOON.



SATURN *and his* Ring.

Note: The Sun is about 10 inches in Diameter, according to the above Proportion of the Planets.

A

VIEW of the HEAVENS:

Being a Short, but Comprehenſive

SYSTEM

OF

MODERN ASTRONOMY.

EXHIBITING,

I. The *Number*, *Order*, *Diſtances*, *Magnitudes*, and *Periods* of all the *Planets* and their ſeveral *Moons*, compoſing our *Syſtem*, which the *Learning* of the preſent Age eſteems as ſo many *Worlds* full of *Inhabitants*.

II. The *Length* of the *Day* and *Year*, with the *Variety* of the *Seaſons* in each *Planet*; and alſo the *Phænomena* of the *Heavens* to the *Inhabitants* thereof.

III. Some Account of the *Comets*, their *Number*, *Periods*, and *Appearances*; and alſo the *Directions* of their *Fiery Trains* thro' the Heavens; with probable Conjectures of the *Uſes* of thoſe *amazing Bodies*.

IV. The *Number*, *Magnitude*, and *Diſtances* of the *Fix'd Stars*; with their *Diviſions* into *Signs*, *Catalogues*, and *Conſtellations*.

V. The *direct* and *retrograde Motions* of all the *Planets*; as alſo, the Reaſon why they ſometimes appear *ſtationary*, or *not to move at all*.

VI. The *Nature* and *Cauſes* of *Eclipſes*, both of the *Sun* and *Moon*; with an eaſy and expeditious *Method* of calculating the *Eclipſes*, which will happen in any Year.

VII. The *Deſcription* and *Uſe* of a curious *Aſtronomical Clock*, which will ſhew the *Hour of the Night* by the *Stars*.

TO WHICH IS ADDED,

The USE of the CÆLESTIAL GLOBE;

WITH

Its *Application* to a Number of very intereſting *Problems*. Concluding with ſome curious *Phænomena* upon the *Sun* and *Moon* exhibited in a *darkened Room*; and a few *ſelect Paradoxes*, intended to excite the Attention of the Learner.

The whole *illuſtrated* with *Copper-plates* of the *Syſtem*, the *Sun*, *Moon*, *Eclipſes*, &c. and diſpos'd in ſo *eaſy* and *natural* a Manner, as to be underſtood in a *few Days*.

By the Rev. Mr. TURNER, late of *Magdalen-Hall*, *Oxford*,
Author of The *View* of the *Earth*;—*Plain Trigonometry* Render'd *Eaſy* and *Familiar*;
—*Syſtem* of *Gauging*;—and *Chronologer Perpetual*.

——*The WORLDS were framed by the* WORD *of GOD.* PAUL.

LONDON:
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TO

THE RIGHT HONOURABLE

GEORGE HENRY EARL OF LICHFIELD,

CHANCELLOR;

TO THE REVEREND

THE VICE-CHANCELLOR;

AND TO THE

HEADS OF HOUSES,

AND

MEMBERS OF CONVOCATION,

IN THE

UNIVERSITY OF *OXFORD*,

THIS

COMPENDIUM OF ASTRONOMY,

(Drawn up with a View to render the firſt Rudiments of ſo illuſtrious and uſeful a Science more eaſy and practicable to the Minds of Youth, and particularly of thoſe who receive their Education in that antient and venerable Seat of Learning,)

IS

WITH THE MOST PROFOUND HUMILITY ADDRESSED,

AND

THEIR PROTECTION AND FAVOUR MOST RESPECTFULLY CRAVED,

By THE AUTHOR.

A SHORT

SYSTEM

OF

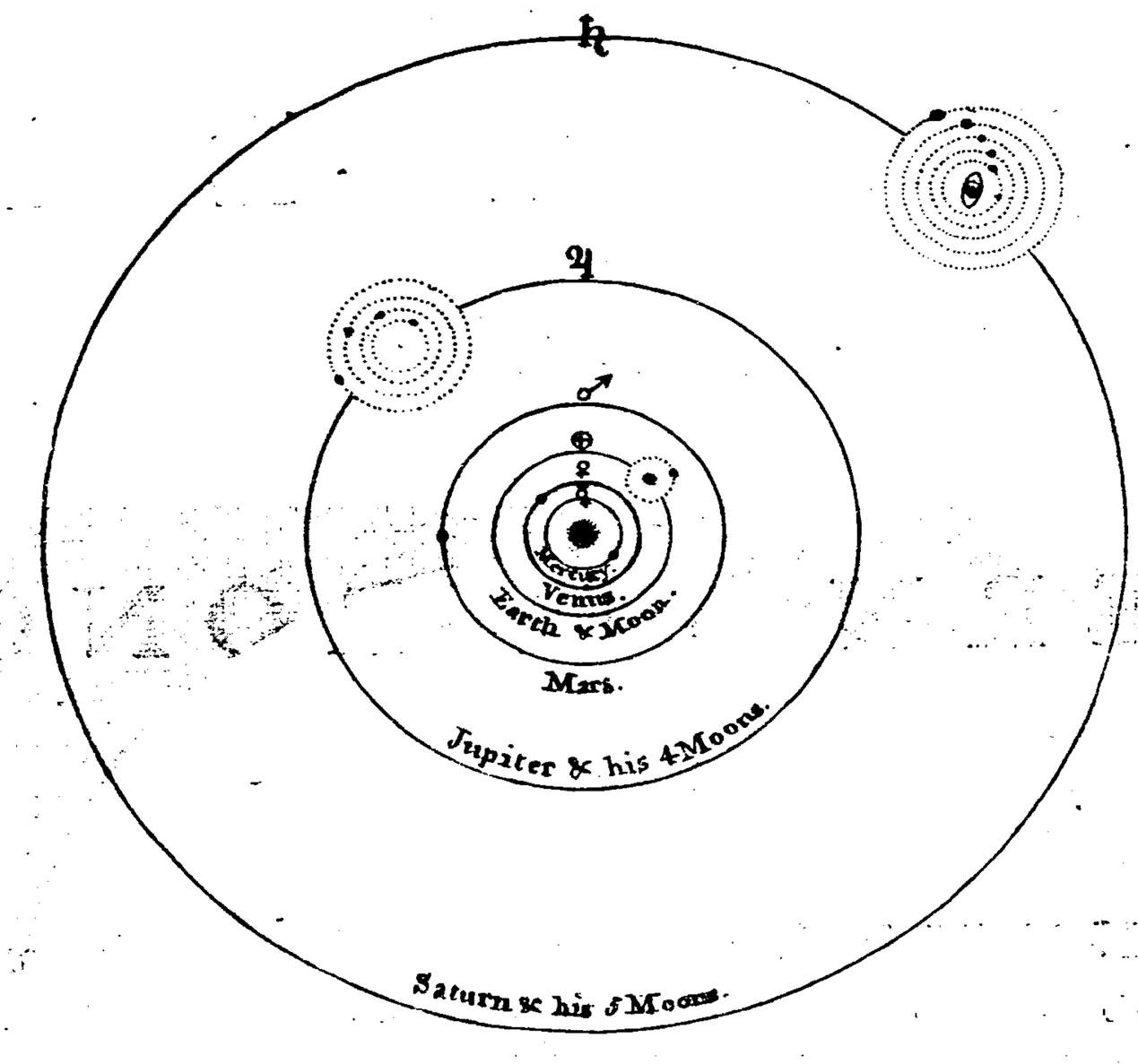
MODERN ASTRONOMY.

ASTRONOMY is that Part of *Learning*, which contemplates the *Number*, *Order*, *Diſtances*, *Magnitudes*, *Periods*, and *Appearances* of the Heavenly Bodies; as the *Sun*, *Moon*, *Planets*, *Comets*, and *Stars*: —And is a *Knowledge*, which contributes not only to the Enlargement of our *Ideas* of the *Immenſity*, *Magnificence*, and *tranſcendent Grandeur* of GOD; but alſo affords the *ſublimeſt* and moſt *ſatisfactory Entertainment* to the *Underſtanding* and *Mind* of *Man*.

When we look up to the *Heavens*, which Way ſoever we turn our Eyes, ſome of theſe wonderful *Luminaries* preſent themſelves to our View: And, as GOD hath told us—that *He ordained them for* Signs *and for* Seaſons;—*for* Days *and for* Years;—it is certainly our *Duty* to obſerve their ſtated Periods, that They may anſwer the great End—ſo wiſe—ſo beneficent a *Providence* intended they ſhould.

ASTRONOMERS, in Conſequence of this divine Appointment, to determine the *Times* and *Seaſons*,—have found, by their repeated Obſervations, that ſeveral Bodies move round the *Sun*: And, as they appear through the *Teleſcope* to be large *Globes* of *Earth*, like our own, (and, that our *Earth*, viewed from them, would appear as they do to us) have juſtly concluded them to be *Worlds* enlighten'd and warm'd by the *Sun*, as ours is, and inhabited by various *Species* of *Beings*; though perhaps very different from thoſe on our Globe; but properly form'd and conſtituted, for the Situation GOD hath placed them in there.

The *Names* of the ſeveral *Globes* or *Planets*, moving round the *Sun*, and compoſing our Syſtem, together in the Order in which they revolve, are—— Firſt, *Mercury* (☿)*—next, *Venus* (♀)—the Third, our *Earth* (⊖) with the *Moon* (☽)—the Fourth, *Mars* (♂)—the Fifth, *Jupiter* (♃) and his 4 *Moons* —the Sixth, *Saturn* (♄) and his 5 *Moons:* All which are repreſented at their proper Diſtances, with reſpect to each other, from the *Sun*, in the *Scheme* at the Beginning of the Book; or in This here delineated.



What Kind of *Syſtem* was received in the firſt Ages of the World, has not been tranſmitted to us; but this *Syſtem* we find taught and profeſs'd by *Pythagoras*, a learned *Greek* Philoſopher, about 500 Years before *Chriſt*. After his Time, it lay dormant, till *Nicholas Copernicus*, a *Clergyman* in *Pruſſia*, reviv'd it about the latter End of the 15th Century; and now it has gain'd the Eſteem of the Learned World †.

In this *Syſtem* we ſee, as in a Glaſs, the Beauties and Harmony of the *Univerſe* diſplay'd; for here are neither *ſolid Orbs* nor *Chryſtaline Heavens* to carry the Planets round, as vainly imagined by *Ptolemy* and Others; but *every Thing* appears in a moſt *ſimple*, *rational*, and *demonſtrable* Order.

It is made up and adorn'd with 17 *Bodies*, which we ſhall immediately proceed to ſpeak of, and in the *Order* and *Situation* they are found in the *Syſtem* itſelf..

* The Characters placed with the Names of the Planets, are, for Brevity's ſake, commonly uſed by Aſtronomers, inſtead of the Words at Length; as ☿ for *Mercury*; ♀ for *Venus*, &c.

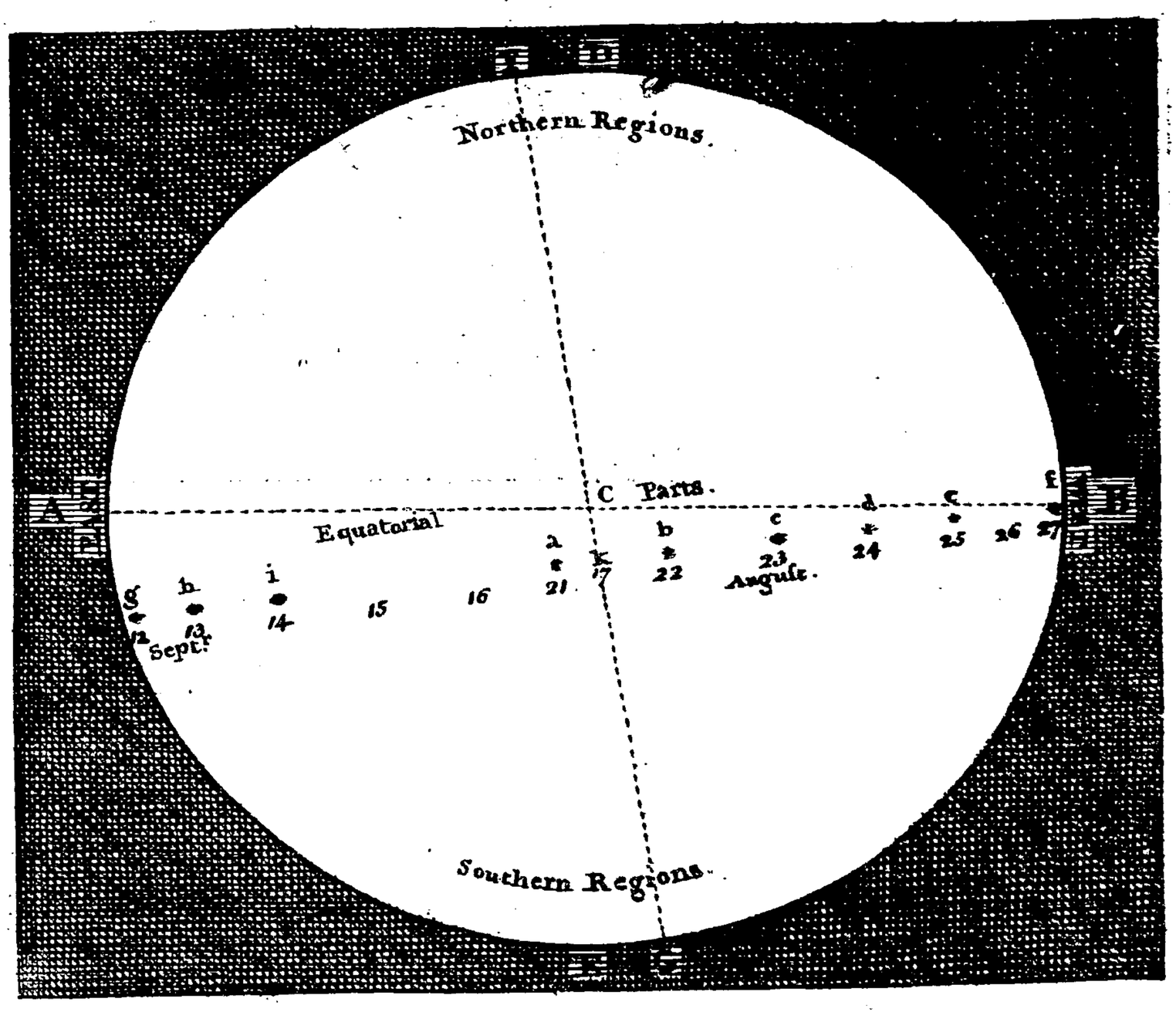
† Moſt of the Antients (not acquainted with Mathematical Learning) took it for granted that the Earth *ſtood ſtill*, and the Sun *moved*, becauſe it appear'd to do ſo. Accordingly, their moſt famous Syſtem, publiſhed by *Ptolemy*, an *Egyptian Aſtronomer*, about 138 Years before *Chriſt*, ſuppoſes the Earth immoveably fixed in the Center of the Univerſe, and the 7 Planets, viz. *Moon*, *Mercury*, *Venus*, the *Sun*, *Mars*, *Jupiter*, and *Saturn*, to revolve in Circles round it. Beyond theſe is placed the Firmament of the *fixed Stars*; then two Chryſtaline Spheres: All which were included in, and received Motion from the *Primum Mobile*, which conſtantly carried all thoſe vaſt and ſolid Orbs about the Earth in 24 Hours, from Eaſt to Weſt.——But this *Syſtem* being found to be too much accommodated to *Senſe* to ſtand the Teſt of Art; others were contrived and publiſhed at different Times; but all of them being embarraſſed with many Difficulties and Abſurdities, were embraced by a *few*; and at laſt were obliged to give Way to the only true and rational *Solar Syſtem*, reſtored by *Copernicus*, as mentioned above.

Of

Of the SUN.

FIRST, we find the *Sun* in the Center of the *Syſtem*, immoveable from thence, having no *circular* Motion in an Orbit, but a *central one* only about his own *Axis*, in the Space of 25 Days and a Quarter, as diſcover'd by viewing him through a *Teleſcope*. He is about 800.000 Miles in *Diameter*; is one Million of Times larger than our Earth; and by his Rotation diſpenſes *Light*, *Heat*, and *Motion*, to all the Planets revolving round him.

By obſerving the *Sun* through a good Glaſs, he generally appears to have one or more *black Spots* on his Body, which come on the *eaſtern* Side, paſs over his Face, and go off on the *weſtern*, in a little more than 13 Days, and in the ſame Space of Time return again. By theſe Spots, not only his Rotation on his *Axis* was diſcovered as above, but alſo that his *Axis* leans or inclines to the Orbit of the Earth in an Angle of about 82 Degrees. The Places, and Manner in which a large Spot appear'd to paſs over the Sun's Diſk, in *Auguſt* and *September*, 1764, are as here delineated.



On the 21ſt of *Auguſt* the *Spot* was ſeen at *a*; on the 22d at *b*; the 23d at *c*; 24th at *d*; on the 25th it was at *e*; the 26th not obſerved; on the 27th it appeared at *f*; on the 28th not obſerved; on the 29th ſuppoſed to be on the *weſtern* Edge. After 13 Days Abſence, *i. e.* on Sept. 12th, the *Spot* appeared again on the *eaſtern* Edge at *g*; on the 13th Day it was at *h*; on the 14th at *i*; the two following Days were cloudy; but on the 17th it was found at *k*; having completed a Revolution.——FG repreſents the *Axis* of the Motion of the Spot. F the *North-pole*, and G the *South-pole*. ACB is the Ecliptic, or Tract oppoſite the Earth's Orbit. D and E its two Poles. This Spot was about a *thirtieth* Part of the Diameter of the Sun, conſequently was near 26.000 Miles in Length; its Breadth was ſomething leſs.—A Spot, leſs in Diameter than our Earth, is not viſible without a good Glaſs *.

* Theſe *Solar Spots* do not always remain the ſame, but ſometimes old ones vaniſh, and afterwards others ſucceed in their Room; ſometimes ſeveral ſmall ones gather together and make one large Spot; and ſometimes a large Spot is ſeen to be divided into many ſmall ones. But, notwithſtanding theſe Changes, they all turn round with the Sun (towards the Weſt), in the ſame time, which is an undeniable Proof they are on his Surface, and not at a Diſtance from him.

Whilſt

Whilſt the *Sun* turns thus on its *Axis* in 25 Days and a Quarter, it throws off from itſelf a fine ſubtle Matter, which is extended through all Parts of the *Syſtem*. This Matter is what conſtitutes Light; and comes with ſuch Rapidity, that it arrives from the Sun hither in ſeven or eight Minutes Time. It paſſes through the Pores of *Glaſs* and other tranſparent Bodies, with little or no Reſiſtance; but when it falls upon Bodies it cannot penetrate, it is reflected to the Eye, and ſo renders them viſible. By this Means, we know that the *Planets* are *opaque*, or dark Bodies in themſelves, and ſhine only by this reflected Light; for when the Sun is in ſuch Poſition that it cannot ſhine upon that Part of them next us, they become obſcure and inviſible.

There are *ſix Primary* or principal *Planets*, and *ten Moons*, which receive their Light from the Sun, viz. *Mercury*, *Venus*, the *Earth* and *Moon*, *Mars*, *Jupiter* and his *four Moons*, *Saturn* and his *five Moons*. Each *Primary* Planet deſcribes a large *Orbit* round the *Sun*, and being placed at different Diſtances, one beyond the other, make their Revolutions in different Periods of Time.

In theſe *Revolutions* of the Planets, there is one thing very remarkable, which is, that they are all made the *ſame Way*, *i. e.* from *Weſt* towards the *Eaſt*, and oppoſite the *middle* or *equatorial* Parts of the *Sun*; which cauſed ſome *Philoſophers* to imagine they were carried about by a *Vortex* or *Whirlpool* of *Æthereal Matter*. But many Obſervations made on the Heavenly Bodies by the *Moderns*, have ſufficiently confuted that Opinion *.

*** If the young *Aſtronomer* has a Mind to obſerve the *Spots* upon the Sun; the beſt Way will be to uſe a *Refracting Teleſcope* of about ſix or eight Feet,—or a *Reflection* one of two or three, with a *ſmoaked Glaſs* placed before the Eye-glaſs next the Eye, which will take off the glaring Light, and render the Spots viſible. By this Method their Appearances may be obſerved, Day by Day, and the Tract they deſcribe in their Paſſage over the Sun's Diſk eaſily aſcertained.—Or, the Image or Picture of the Sun, with its Spots, may be received into a *dark Room*, through a Teleſcope of one or two Feet long, (without a ſmoaked Glaſs) upon a Piece of white Paper, which may be magnified or diminiſhed, by bringing the Paper nearer or further from the Glaſs, to the Dimenſions you pleaſe. This is an innocent and eaſy Way; but one Inconvenience attends it, which is, that the *Image*, ſeen upon the Paper, always appears in an *inverted Poſition*.

* This will be further conſidered, when we come to treat of the Motion of Comets.

Of the Planet MERCURY.

NEXT the Sun, at the Diſtance of 32 Millions of Miles, we find *Mercury* performing his *Revolution* in the Space of 87 *Days*, 23 *Hours*, and 13 *Minutes*.—He is ſeldom ſeen with the naked Eye, becauſe of his *Nearneſs* to the *Sun*, being never diſtant (either *before* or *after* him) more than 27 Degrees: And, becauſe the *Heavens*, at the Time *Mercury* is at his greateſt Diſtance from the Sun, are ſo *illuminated*, there can be no Obſervation made to diſcover the *Spots* on his Body, by which his *Rotation* on his *Axis* might be certainly diſcovered.—The Diameter * of this Planet is about 2460 *Miles*; which makes him near 30 Times *leſs* in Bulk than our *Earth*.

The *Year* †, to the *Inhabitants* of this Planet, (for it is the Opinion of the *Learned*, that the ſeveral *Planets* are ſo many *Worlds*, furniſh'd with Beings of different Kinds as our Earth is,) is ſcarcely equal to *one Quarter* of Ours: But as they are almoſt *three Times nearer* the Sun than we are, his *Face* muſt conſequently appear *three Times bigger*; and his *Light* and *Heat* almoſt *nine Times greater* than with Us. This Degree of Heat would continually keep our Waters *boiling*, and render it impoſſible for Us to live; but the Bodies of *Animals* and *Vegetables* there, are, no doubt, properly temper'd to ſuſtain it. *They*, as well as their *Planet*, may be conſtructed more *denſe*, *firm*, and *compact* than we are here; and may require that very Degree of Heat to ſupport them in Life, which would deſtroy Beings of our ſofter *Texture*, and conſume them away.

The *Length* of the *Day*, and the *Variety* of the *Seaſons* there, is totally *unknown* to our *Aſtronomers* at preſent: For they have not been able (by Reaſon of his *Nearneſs* to the Sun, and the great Illumination of the Heavens, when at his greateſt Diſtance) to diſcover the *Inclination* of his *Axis*, or the Time he *revolves* about it.

The *People* in this Planet will obſerve the *Spots* on the *Sun* much plainer than we can, and, conſequently, be enabled to diſcover his Rotation on his *Axis*, and the better aſcertain what thoſe Spots are. As to the reſt of the Planets above *Mercury*, their Appearance will be much the ſame as to us at the Earth. So that *Venus* and our *Earth*, when in *Oppoſition* to the Sun, will ſhine with a *full Face*, and conſequently afford a great Light to this Planet by Night. But *Mars*, *Jupiter*, and *Saturn* will not give him quite ſo much as they do us, by Reaſon of their greater Diſtance from him.

* The *Diſtances* of the Planets from Us, and from one another; and alſo their *Diameters*, are obtained by *Trigonometry*.—An eaſy Method of making thoſe Calculations, is ſhewn in my Treatiſe on that Subject.

† The *Revolution* of a Planet *round the Sun*, is called the *Annual* or *Yearly* Motion, becauſe they have all the Alterations of the Seaſons, and Varieties of the Year, complete in that Revolution.—And the *Rotation* of a Planet *round its Axis*, is called the *Diurnal* or *Daily* Motion; becauſe, by this Means, each part of their Surfaces are carried ſucceſſively towards and from the Sun, which always illuminates that Half next him, making it Day; whilſt the other Half remaining in Darkneſs, muſt conſtitute its Night.

The *Periods* of the Planets are determined by obſerving the Time of their Departure from a fix'd Star, till they arrive to the ſame Star again.—And the *Diurnal* Rotation round their *Axiſes* is diſcovered by *Spots* ſeen with the Teleſcope upon their Diſks, which *Spots* appear to paſs over their Faces in a certain Space of Time, and after being abſent the ſame Time, return again, and paſs over their Diſks as before.

Of the Planet VENUS.

NEXT beyond *Mercury* is the glittering Planet *Venus*: She makes her periodical Revolution in 224 *Days*, 16 *Hours*, and 49 *Minutes*, at the Diſtance of 59 Millions of Miles from the Sun. She is obſerved to turn upon her *Axis* in 23 *Hours*, and her Diameter is about 7906 Miles, which is nearly equal to our Earth.

This Planet, as well as *Mercury*, can never be ſeen at *Midnight*; but is *viſible* only three or four Hours in the *Morning* and *Evening*, according as ſhe is *before* or *after* the Sun. When ſhe is in that Part of her Orbit *weſt* of the Sun, ſhe riſes in the *Morning* before him, and is called the *Morning-ſtar*. When ſhe is on the *eaſt* Side of the Sun, ſhe ſets in the *Evening* after him, and is then the *Evening-ſtar*.

Since theſe two Planets, *Venus* and *Mercury*, always accompany the Sun, (and are never farther from him than, the latter about 27 Degrees, and the former 47,) *Aſtronomers* well know, that the Earth's Orb muſt circumſcribe their Orbits; and that they revolve about the Sun in Circles much *nearer* than we are: Hence it is, they are never found one-twelfth or one-eighth Part of a whole Circle from him; *which* they would be, if the *Earth* was in the *Center* of the *Syſtem*, and they went round us *.

To the *Inhabitants* of this Planet, the *Sun* will appear almoſt *twice as big* as he does to us: His Face, and conſequently his *Light* and *Heat*, muſt be almoſt *four* Times greater. The *Year* in that Planet is about *two-thirds* of our Year, and the Length of the *Day* 23 Hours.

They who obſerve the Heavens there, will ſee *four Planets* above them; viz. the *Earth*, *Mars*, *Jupiter*, and *Saturn*; and *one* below, which is *Mercury*. When our *Earth* is in *Oppoſition* to the Sun, it will appear to ſhine (in the Night) there with a full Face, and very bright. The *Moon* will always ſeem to wait upon the Earth, and never appear more than half a Degree (or two Hands Breadth) from it. *Mercury* will accompany the Sun, and be ſeen as a *Morning* and *Evening* Star by Turns, juſt as *Venus* does to us.

Some *Aſtronomers* think, they have obſerved a ſmall *Moon* belonging to this Planet, about one-fourth as big as *Venus*: And the Reaſon we don't frequently ſee it, is owing, perhaps, to the Unfitneſs of its Surface to reflect the Light ſo far. And indeed, if this Planet has no *Moon*, I can't conceive how the Inhabitants will diſtinguiſh their Times, ſince the *Inclination* of its *Axis* is very little, if any, and the Sun always in their *Equator*; conſequently there muſt be continually the ſame Seaſons of *equal Day* and *equal Night* all round her Orbit.

* *Venus* and *Mercury* appearing through the Teleſcope, ſometimes *horn'd*, and ſometimes *gibbous*, like the Moon, is another Proof of their going round the Sun in Orbits within the Earth's Orbit; and for this Reaſon they are called *inferior Planets*. *Venus* is ſix Times nearer us at her *inferior Conjunction*, when on this Side the Sun next us, than at her *ſuperior Conjunction*, beyond the Sun. She conſequently appears much bigger in the former Situation than in the latter. For though at her inferior Conjunction ſhe ſhews but a ſmall Part of her Diſk, and looks through the Teleſcope like a Moon three Days old; yet, on Account of her Nearneſs, that ſmall Part contains a greater Area of Light than the whole Diſk does, when at her greateſt Diſtance beyond the Sun. In this Situation ſhe has been often ſeen in the *Day* near the Sun, and been taken, by the common People, for a *New Star*.

Of

Of the EARTH.

THE *Earth*, on which we live, is one of the Planets; the next beyond *Venus*. She moves round her Orbit at the Diſtance of 81 Millions of Miles from the Sun, and completes her Revolution in 365 *Days*, 5 *Hours*, and 49 *Minutes* *. This produces the ſeveral Seaſons of the Year, *Winter*, *Summer*, *Autumn*, and *Spring*.

Beſides the *Annual* or yearly Motion, ſhe has a *Diurnal* one upon her Axis from *Weſt* to *Eaſt* in 24 Hours, which makes the Sun and all the heavenly Bodies appear to move round from *Eaſt* to *Weſt* in the ſame Time. This is the Cauſe of *Day* and *Night*; and of the *riſing* and *ſetting* of all the heavenly Bodies.

If the *Earth* was view'd from the Sun, as ſhe revolves in her Orbit, ſhe would ſeem to paſs (as a ſmall Star) through the Heavens, deſcribing a Circle among the *fixed Stars*. Which Circle *Aſtronomers* have divided into twelve equal Parts, correſponding to the twelve Months of the Year; and have ſuppos'd each Part cover'd with an Image, or Picture of ſome living Creature, and call'd that Space by the Name, or Sign of the Image depicted there.

The *Names* and *Characters* of the twelve Signs are,

Aries	*Taurus*	*Gemini*	*Cancer*	*Leo*	*Virgo*	*Libra*	*Scorpio*	*Sagitarius*	*Capricornus*	*Aquarius*	*Piſces*,
♈	♉	♊	♋	♌	♍	♎	♏	♐	♑	♒	♓
Ram	Bull	Twins	Crab-fiſh	Lion	Virgin	Ballance	Scorpion	Archer	Sea-goat	Water bearer	Fiſhes.

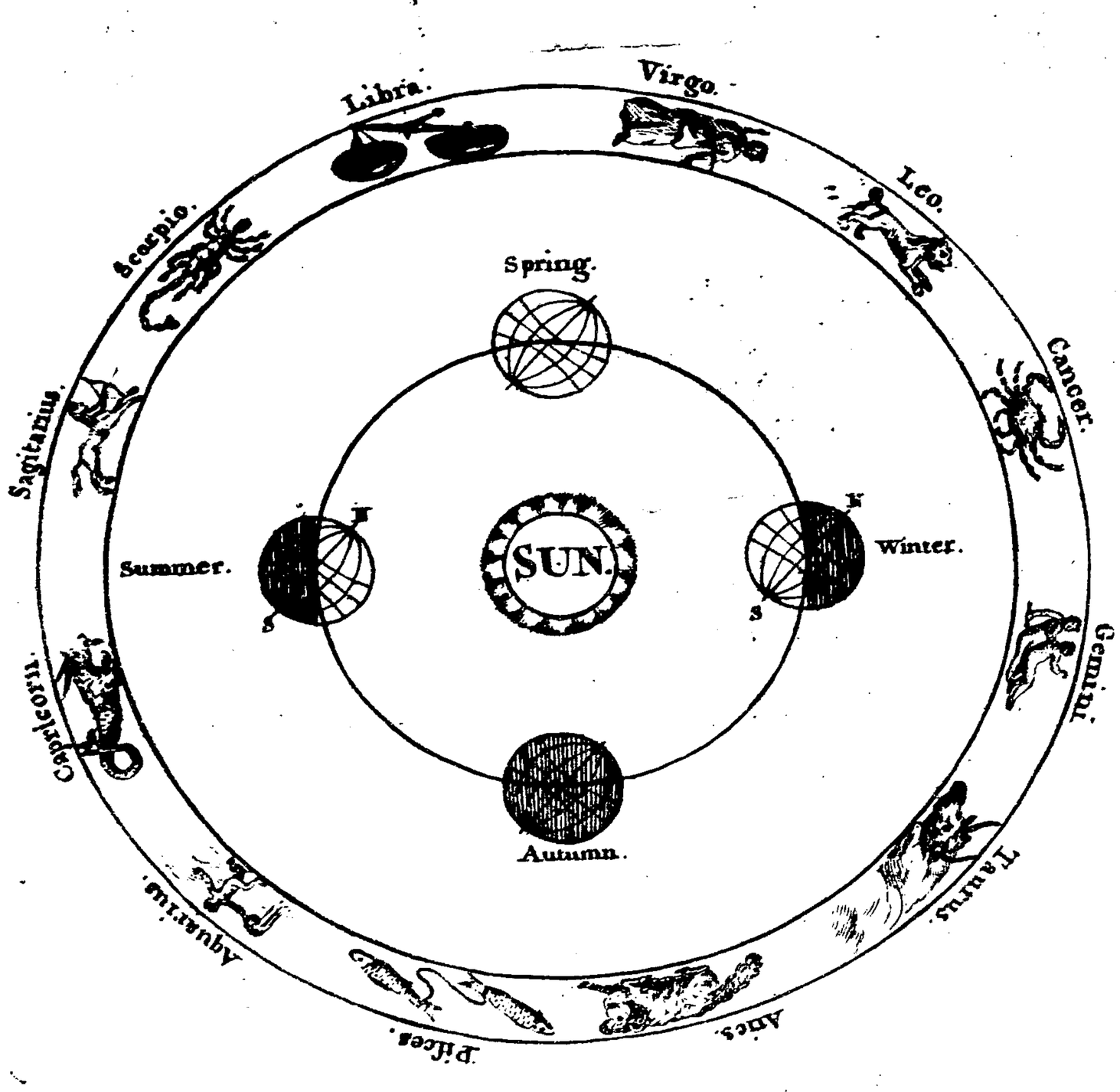
When the *Earth*, moving round her Orbit, comes oppoſite to any of theſe Pictures, ſhe is ſaid to be in that *Sign*, which the Picture expreſſes. And as the *Earth*, like the reſt of the Planets, revolves from *Weſt* to *Eaſt*, the *Sun* will appear to have an *Annual* Motion the ſame Way, and in the ſame Tract, but ſtill in the oppoſite Point. For when the *Earth* is in that Part marked *Aries*, or the *Ram*; the Sun will be in that Part mark'd *Libra*, or the *Ballance*; and ſo of any other; as may be ſeen in the *Earth*'s Orbit delineated on the other Side.——This Circle is called the *Ecliptic Line*, becauſe the Planets ſeldom eclipſe each other, unleſs they appear upon that Line, and in the ſame Point, and then the nearer may happen to obſtruct our View of the other beyond it.

* The Revolution of the *Earth* in her Orbit, which is the Length of a *Solar Year*, is exactly 365 Days, 5 Hours, and 49 Minutes; but we (to avoid Fractions) account it 365 Days, 6 Hours, which is 11 Minutes too much. Theſe 11 Minutes, in about 134 Years, amount to one whole Day; which Day being retain'd, muſt make the *Sun* appear to recede one Day back in the Kalendar in that Time. Conſequently, the *Vernal Equinox*, which happened about the 21ſt of March, at the Time of the *Nicene Council*, (in 325,) muſt, after 134 Years, happen on the 20th, and in 134 Years more, on the 19th, and ſo on. In our Time, the *Equinox* was gone back to the 10th of March; *i. e.* 11 Days from the Place it was in before; and would, in Time, have retreated through the whole Kalendar, and thereby have thrown all the *moveable* Feaſts into the greateſt Confuſion.—To remedy this Inconvenience, the Legiſlative Power, by an Act paſſed in 1752, threw out the 11 *additional Days*, by calling the 3d of September the 14th, in Order to bring the *Equinox* to the Place it was at when that Council was held. And, to keep it fix'd there, order'd, that three Days every 400 Years ſhould be omitted, in the following Manner; viz. the Years 1800 and 1900, which ſhould have been *Leap-years*, ſhall be accounted *common Years*, of 365 Days only. But the Year 2000, and every fourth Hundred Year after that, ſhall be a *Leap-year* of 366 Days, the intermediate Hundreds only *common Years*. By this Means, our Reckoning will not vary a *Day* again, in leſs than 8 or 10000 *Years*, which is very inconſiderable.

*** Our Times and Seaſons now correſpond with thoſe at the Calling of the firſt *Chriſtian Council*, when the Affairs of the Church were ſettled by Order of the *Emperor Conſtantine the Great*, in the Year of *Chriſt* 325.

If the *Earth* had no *Inclination* of its *Axis* to the Plane of its Orbit, the Sun would ever appear in the Equinoctial, making the Days and Nights equal throughout the Year. But by having an *Inclination* from the Perpendicular of $23\frac{1}{2}$ Degrees, and directing the Poles always to the ſame Points of the Heavens; hence ariſes the Diviſion of the *Earth* into *Zones*, as exhibited in my *Geography*, and all the Variety of the Seaſons we enjoy; as is clearly expreſſed in the following Figure.

By this *Inclination*, the Sun is made ſometimes to viſit the *northern* and *ſouthern* Parts, making them more warm and comfortable; and leaving the equinoctial Parts for a ſmall Time, makes them more cool and fit for Habitation.



When the *Earth* is in *Libra*, the Sun will appear to be in *Aries*. Then begins our *Spring*. The Sun is over the *Equinoctial*, and his Light is diffuſed equally from Pole to Pole, making the Days and Nights every where equal. This happens the 21*ſt of March*.———When the *Earth* is arrived at *Capricorn*, the Sun is then at *Cancer*. Now the *North-pole* is turn'd not only towards the Sun, but all the northern Parts are much nearer. His Rays now ſtrike us more forcibly; while the *ſouthern* Parts are turn'd from the Sun; and the Pole itſelf, and the Parts round it, are involved in Darkneſs. This is the Beginning of *Summer*, falls upon *June* 21*ſt*, and the Days are at the longeſt. ———From hence, as the *Earth* advances, the Sun begins to leave the northern Parts, till ſhe arrives at *Aries*, where the Sun appears in *Libra*. He is then got over the *Equinoctial* again, and diſtributes his Light and Heat equally over the Globe from Pole to Pole, making *equal* Day and Night, as in the Spring. This is the Beginning of *Autumn*, and happens *September* 23*d*.———As the *Earth* goes on, the Days ſtill continue to ſhorten, till ſhe arrives at *Cancer*, at which Time the Sun will be found in *Capricorn*. Now the *ſouthern* Parts, you ſee, are turn'd towards the Sun, and ſtrongly illuminated, making their Summer; whilſt the *northern* Parts are turn'd from him, and the Pole is involv'd in Darkneſs, as the *ſouthern* was in the oppoſite Part of the Orbit. Our Days are now at the ſhorteſt; the Sun's Rays fall more oblique and feeble; and *Winter* now begins, *December* 21*ſt*. Here,

Here it may not be improper to obſerve that the Orbit of the *Earth* is not perfectly *circular*, but a little *elliptical:* For which Reaſon, the *Sun* will be nearer the *Earth* at one Time than another; and the *Earth* will move ſlower and faſter*: Whence it follows, that ſhe will paſs over one Half of her Orbit in leſs Time than the other. For, from *Autumn* September 23d. to *Spring* March 20th. is *eight* Days leſs than from *Spring* to *Autumn* again. And ſo many Days is our *Summer* Half-year longer (when the *Sun* is farther off) than our *Winter* Half (when the *Sun* is nearer) as any one may eaſily perceive, if he will only count the Days from theſe Periods in an *Almanack*.

The *Figure* of the *Earth* is that of a *round Ball*, as is evident from the Obſervations of thoſe who have ſailed round it; as alſo from its *Shadow* being always *round* when it is ſeen to fall upon the Moon and eclipſe her. But the Parts at the *Equator* have been found, by Sir *Iſaac Newton*, to be higher than thoſe at the *Poles* by about 34 Miles. And it is very neceſſary it ſhould be ſo conſtructed, elſe the Waters of the Ocean there, would have been whirled over the Land, by the *Earth*'s *Diurnal* Motion.

The *Circumference* of the *Earth* is ſuppoſed to be divided into 360 equal Parts, call'd *Degrees*, and each of theſe into 60 Parts, call'd *Minutes*. Now our Countryman, Mr. *Norwood*, found by meaſuring from *London* to *York*, in the Year 1655, that one of thoſe Degrees upon the *Earth's* Surface contain'd $69\frac{1}{2}$ Miles; therefore its *Circumference* muſt be 25.020 Miles, and its *Diameter* 7964.

The *Earth* is ſurrounded with a thin vaporous Air, call'd its *Atmoſphere*: This reaches every where to the Height of about 46 or 47 Miles; and ſerves to ſuſpend the *Clouds*, furniſh us with *Winds* and *Rains*, and ſerves to the common Purpoſes of *Breathing*; it is alſo the Cauſe of the Morning and Evening *Twilight*, and all the Brightneſs and Glory of the Sky.

Every *Planet* is ſuppoſed to be ſurrounded with ſuch an *Atmoſphere*, which ſerves to the ſame Purpoſes there, as ours does here †.

* The common People think that the *Sun* moves, and that the *Earth* ſtands fixed in the Centre of the Univerſe; and, when they argue on this Subject, produce thoſe Texts where mention is made of *the Foundation and Pillars of the Earth*; and that it *abideth for ever*.—Alſo, that *the Sun riſeth, goeth down, and haſteth to the Place where he aroſe*.—That *the Sun cometh forth like a Bridegroom out of his Chamber, and rejoiceth as a Giant to run his Courſe*.—That *the Sun ſtood ſtill over* Gibeon; *and went back ten Degrees on* Ahaz's *Dial*. But all theſe Expreſſions are to be underſtood according to the *Appearance* of Things, not as they *are* in *Fact*. With the Sacred Writers it was uſual, when they ſpake of the *Sun* or *Earth*, to expreſs themſelves according to the *Conceptions* and *Ideas* of the People rather than the real Nature of the Syſtem. And even the *Aſtronomers* themſelves, though they know and teach the Contrary, yet in their common Converſation ſay—*the Sun riſes*—*the Sun ſets*—*the Sun moves*, &c. For did they alledge the Motion to be in the *Earth*, they would be under a Neceſſity of explaining themſelves every Time they ſpake to the *Vulgar* on that Head.—But there are *many* Places in Scripture which clearly aſſert the *Situation*, *Figure*, &c. of the *Earth*, the *Plurality of Worlds*, *Antipodes*, &c —As, (1ſt.) where God is ſaid *to frame the Worlds by his Word*. Now *Worlds* muſt imply *more than one*, conſequently the *Planets* may be inhabited Worlds.—*He made the Round World*, i. e. the World, or *Earth* we inhabit muſt be *globular*.—*He hung the World upon Nothing*; i. e. ſuſpended it in the immenſe *Void*.—*He ſhall ſubdue People under us*; i. e. the *Antipodes*.—*And Nations under our Feet*; i. e. the Kingdoms of the *Weſt*.—*The Wind goeth towards the South, and turneth about to the North according to its Circuit*; this expreſſeth the *Trade-winds* and *Monſoons*. ——— And the Rev. Mr. *Kennedy*, in his *Aſtronomical Chronology*, has proved, from the Writings of *Moſes*, that *Time* commenced at the *Autumnal Equinox*.—That the *Earth* began its *annual Motion*, October 25th at Noon; the Sun being then $10^h\ 24'$ to the Weſt of *Greenwich*, i. e. over a Meridian paſſing through the Middle of the vaſt *Pacifick Ocean*.—That this happened, in Coincidence with a *full Moon*, on the fourth Day of the firſt Week at Noon, being *Thurſday*.—And from the Year 1761 was 5768 *ſolar Years*.

† If, from what has been ſaid, the *Learner* underſtands the various Motions of the *Earth*, he will eaſily conceive the Motions of the reſt of the *Planets*. For, they all move in *Orbits*, like our *Earth*, round the *Sun*, which makes, in the ſame Manner, their *Year*.—They alſo revolve upon their

Of the MOON.

THE *Moon* is a *Secondary* Planet, differing from the reſt, becauſe ſhe reſpects the *Earth* for the Center of her Motion; and not only her Globe, but her Orbit is carried (as it were) round the *Sun* together with our *Earth*; for which Reaſon ſhe is called the *Earth's Satellite*, or Attendant.—She makes one Revolution round the *Earth*, with Reſpect to the *fixed Stars*, in 27 *Days*, 7 *Hours*, and 43 *Minutes*: This is called the *Periodical Month*. But the *Earth* having gone on, in that Time, one twelfth Part of her Orbit, and carried the *Moon* with her, ſhe will not arrive to the ſame Poſition, with Regard to the *Sun*, as ſhe was when ſhe began her Courſe, till about 2¼ Days more. Hence, from one *new Moon* to another is about 29½ Days, and this is called the *Synodical Month*; becauſe, at every *new Moon* the *Sun*, *Moon*, and *Earth* are aſſembled in Coniunction, and lie in a right Line, the *Moon* being between them.

In every Revolution of the *Moon* round the *Earth*, ſhe turns once upon her own *Axis*, and that is the Reaſon why the ſame Face is always preſented to our View.

The *Moon* is conſiderably ſmaller than any of the Planets, but by Reaſon of her Nearneſs, ſhe appears the biggeſt; her Diſtance being only 240.000 Miles from us. Her Diameter is found to be about 2175 Miles;—her Circumference 6829; which makes her Globe near 50 Times leſs than ours.

That the *Moon* has *Day* and *Night*, is evident from the Light and Shadow of the *Sun* ſeen upon it, moving round it from *Weſt* to *Eaſt* in one Month.—That ſhe has *Summer* and *Winter* is clear from her preſenting ſometimes more of her *northern* Parts, and at other Times more of the *ſouthern*; by which alſo, we learn that her *Axis* inclines (like our *Earth*'s) to the Plane of her Orbit, but not ſo much; hers being only 6½ *Degrees* from the Perpendicular, but ours 23½ *Degrees*.—That ſhe has *Mountains*, *Seas*, and *Valleys*, is manifeſt from the Inequalities and Unevenneſſes in her Surface, which are plainly to be ſeen with the *Teleſcope*.—She is alſo ſupppoſed to have an *Atmoſphere*.—And our *Earth* doth the Office of a *Moon* to the *Lunarians* (if any there) as their Planet does to us.

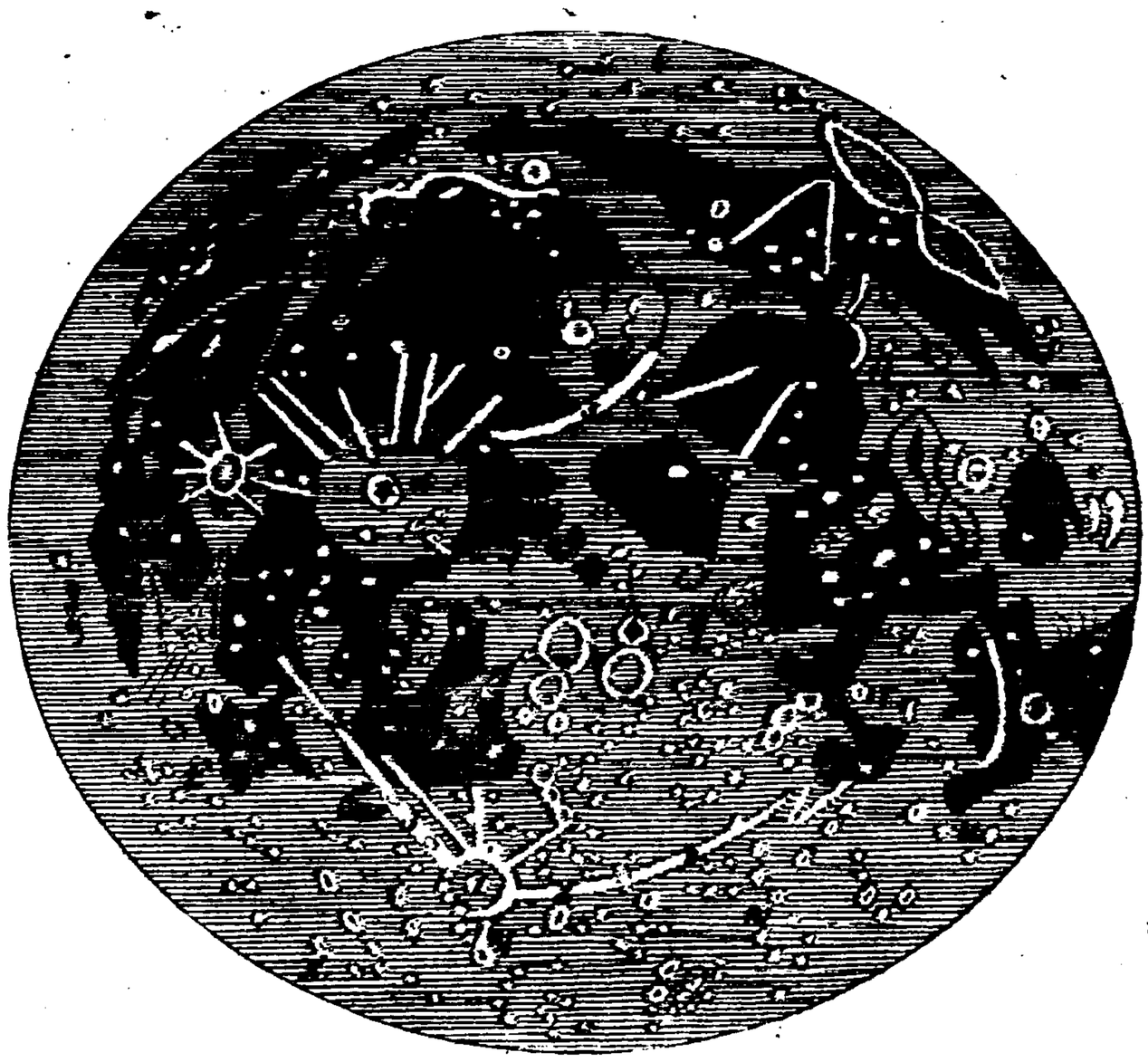
The brighter Parts of the *Moon* are ſuppoſed to be the various *Region of Land*, ſhining by the *reflected* Light of the *Sun*, the darker Parts are *Oceans*, *Seas*, and *Lakes*, which, as they *abſorb* the Light, muſt appear more obſcure; the bright *Spots* and *Streaks* of Light, are judged to be *Iſlands*, *Hills*, and long Ridges of *Mountains*, ſtrongly *illuminated* by the *Sun*.

Axises, which produces the Returns of *Day* and *Night*.—From the *Inclination* of their *Axises* to the Plane of their Orbits, ariſes the Diviſion of their Globes into *Torrid*, *Temperate*, and *Frigid Zones*.—By keeping their *Poles* always directed to the *ſame Points* of the Heavens, they muſt neceſſarily have the varigated Seaſons of *Summer* and *Winter*.—And from their *Atmoſpheres* ariſe *Twilight*, *Winds*, *Miſts*, &c. as upon our *Earth*; only, in ſome *Planets*, theſe *Phænomena* may happen in a *greater* or *leſs* Degree than upon the *Earth* itſelf.

* The *Moon* appears to move every Day towards the *Weſt*: This is cauſed by the *Earth*'s daily Rotation upon her *Axis* the *contrary* Way. But her real Motion, like the reſt of the Planets, is towards the *Eaſt*. For if you obſerve her any Night near a *fix'd Star*, you will find her the Night following conſiderably remov'd towards the *Eaſt*; and the next Night twice as far; and ſo on: Till ſhe (compleating her Round) returns to the Star again.

The

The *Situation* of the ſeveral *Countries*, *Seas*, and *Mountains*, on that Hemiſphere (or Face) which is always preſented to our View, is as here delineated.



The *Oceans*, *Seas*, and *Lakes* are,

a Mare Hyperboreum
b Paludes Hyperboreæ
c Sinus Hyperboreus
d Mare Eoum
e Mare Mediterraneum
f Pontus Euxinus
g Palus Meotis
h Mare Caſpium
i Mare Adriaticum
k Propontis.

The *Countries* and *Iſlands* are,

l Regio Hyperborea
m Sarmatia
n Taurica Cherſoneſus
o Italia
p Mæſia
q Aſia
r Cholchis
ſ Sicilia
t Peloponneſus
u Scythia
w Perſia
x Arabia
y Paleſtina
z Ægyptus
& Lybia
a Inſula Circunna.

The *Mountains* and *Hills* are,

1 Mt. Sinai—2 Mt. Taurus—3 Mt. Sepher—4 Mt. Ætna—5 Mt. Apenninus—6 Mt. Olympus *.

The other Side of the *Moon* we are never permitted to ſee, nor the *Inhabitants* (if any) to ſee Us, without taking a Journey to this Side next us, and ſome of them muſt travel more than 1500 Miles to obtain a Sight of our *Earth* at all.

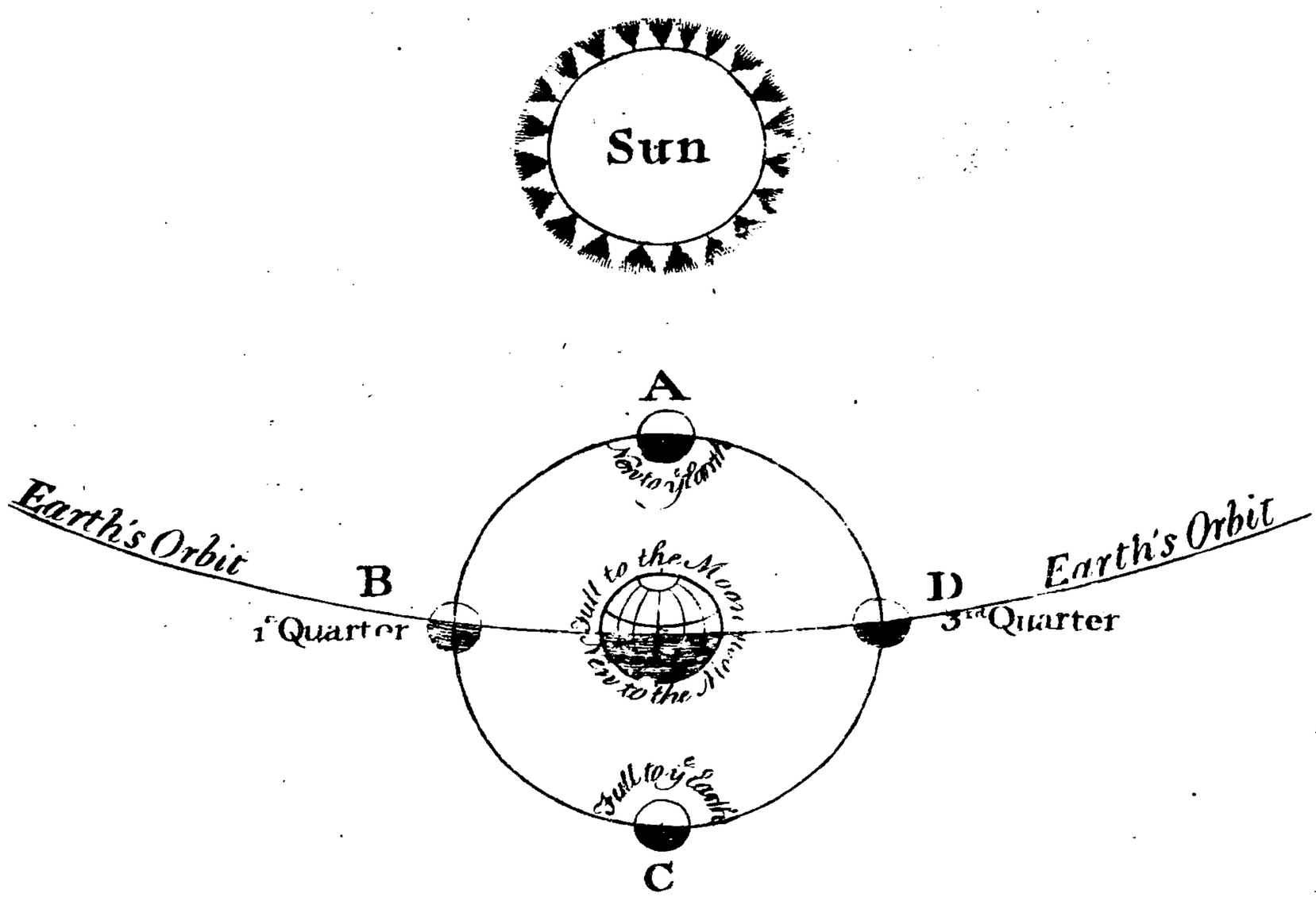
Another Thing, no leſs remarkable than wonderful and curious, is, that thoſe who inhabit the Middle of the Surface next us (as about *Mount Olympus* and *Mare Adriaticum)* will ſee our *Earth* conſtantly *over their Heads*, and *increaſing* and *decreaſing* in Light like a *Moon*; whilſt thoſe who live near the *Borders* will ſee the ſame Appearances continually in the oppoſite Parts of their *Horizon*.

To the *Inhabitants* of the *Moon* in general, the *Magnitude*, *Light*, and *Heat* of the *Sun* are much the ſame as with us here, owing to her ſmall Diſtance from us. But the Length of the *Day* in that Planet is equal to near 30 of

* Some of theſe Mountains are thought to be higher than any on our Earth. Their Heights are eaſily obtain'd by *Trigonometry*. See my Treatiſe on that Subject.

ours; that being the Time ſhe takes to turn once round her *Axis*; ſo that her *Days* and *Months* are of the ſame Length; and the *Year*, to the *Inhabitants* there, is exactly equal to ours, becauſe ſhe turns each *Pole* towards and from the *Sun*, in the ſame manner as the *Earth* does in that Period of Time. But the Variety of Seaſons, with regard to Heat in *Summer* and Cold in *Winter* is much leſs than upon this Globe, ariſing from a much ſmaller Inclination of her *Axis*, which is about $6\frac{1}{2}$ Degrees: Conſequently the *Torrid Zone* muſt be only 13 Degrees—the *Frigid Zones* the ſame—and the *Temperate Zones* 77 Degrees broad.

The *Lunarians* will obſerve our *Earth* to ſhine like a *Moon* to them, as theirs does to us. For, the *Earth* and *Moon* are mutually *Moons* to one another. Only, when they are a *new Moon* to us, we are a *full Moon* to them. And when they appear to *increaſe* in Light, we ſhall appear to *decreaſe* in the ſame Proportion, &c. All this is evident from a bare Inſpection of the following *Scheme*.



From a Sight of this Figure it is manifeſt, that, that Half of the *Earth* and *Moon* next the *Sun* is always illuminated, and the other Half always dark; Conſequently, when the *Moon* is at A, ſhe is a *new Moon*, and inviſible to us; but we are a *full Moon*, ſhining bright to them.—At B, ſhe turns Half her illuminated Side towards us, where ſhe is in the *firſt Quarter*; and we appear to the *Inhabitants* there in the *laſt Quarter*.—At C, ſhe becomes a *full Moon*, ſhining bright upon us; whilſt we are a *new Moon*, and inviſible to them.—At D, ſhe preſents Half the illuminated Face again: Now ſhe is in the *third Quarter*, and we in the *firſt*. When ſhe returns to A her Revolution is complete, and the Appearances begin as before.—As the *Moon* paſſes from A round B to C, ſhe gradually *increaſes* in *Light*;—is Eaſt of the Sun;—and riſes and ſets after him.—But in going from C by D to A, ſhe *decreaſes* in the ſame Manner;—is Weſt of the *Sun*;—and riſes and ſets before him.

There is one Thing further to be obſerved, which is, that the *Light* afforded by the *Earth* to the *Moon* is about 15 Times greater (the *Earth*'s Surface being ſo many Times bigger) than that afforded by the *Moon* to the *Earth*: Which ſtrong Reflection from the *Earth* occaſions that *duſky Light* ſeen on the dark Part of the *Moon* for ſome Days near the *Change*.

Of

Of the Planet MARS.

MARS moves in an Orbit round the Sun, between the *Earth* and *Jupiter*, making one Revolution in the Space of 1 *Year*, 321 *Days*, 23 *Hours*, and 27 *Minutes*; at the Diſtance of 123 Millions of Miles. This Planet is of a *Red Colour*, (ſuppos'd to be owing to the Thickneſs of his *Atmoſphere*, or *Nature* of the *Soil* to reflect that *Redneſs*) and has a Rotation upon his *Axis*, as appears from the *Spots* upon his Body, in 24 *Hours* and 40 *Minutes*. He is about 4440 Miles in *Diameter*, which makes him about ſix Times leſs in Bulk than our Earth.

Mars, when in *Oppoſition* to the Sun, is five Times nearer us than when in *Conjunction*; for this Reaſon he appears much *larger* and *brighter* at one Time than another. In the *Quadrature* he appears almoſt *biſſected* like the Moon, but never *horn'd*, which is a Proof that his Orbit circumſcribes ours, and lies wholly beyond it.

As this Planet is almoſt *Half* as far again from the Sun as our Earth is, his *Inhabitants* will ſee the Sun's Diameter but little more than *Half* as big; conſequently, his *Light* and *Heat* is not *Half* ſo great as it is here. Their *Year* is almoſt *twice as long* as ours, and their *natural Day* is greater by about 40 *Minutes*.

The *Axis* of this Planet (as appears from the Revolution of the *Spots* upon his *Surface*) is nearly at Right Angles to the Plane of the Orbit; conſequently, the *Days* and *Nights* are almoſt *equal* every where over the whole Globe. But Places in different *Latitudes* will partake of different Degrees of *Heat* and *Cold*, on account of the different *Inclination* of the *Sun's Rays* to the *Horizon*, as in the Caſe of our Earth, when the Sun is in the *Equinoxes*, in *March* and *September*.

Though *Aſtronomers* have not been able to diſcover any *Moon* belonging to this Planet, yet it is very probable he has one *, elſe the *Inhabitants* will be depriv'd of that moſt uſeful Diviſion of Time into *Months*, which we have meaſur'd out to us 12 Times in a Year, by that Number of Revolutions of our *Moon* round the *Earth*.

The Spectators of the Heavens in *Mars* will rarely, if ever, ſee *Mercury*, unleſs it is when that Planet, paſſing directly between them and the Sun, appears as a *black Spot* upon his Face, as he does ſometimes to us. *Venus*, there, will appear about as far from the Sun as *Mercury* does with us; and the *Earth* will appear, as far as *Venus* appears to us to be from the Sun; and will become their *Morning* and *Evening Star*, by Turns, juſt as *Venus* does here. And when the *Earth*, ſeen from *Mars*, is in *Conjunction* with and near the *Sun*, ſhe will appear (thro' a Glaſs) *horn'd*, as *Venus* does to us in that Poſition; and its Satellite, the *Moon* will be of the ſame Figure, if it can be ſeen there, and at its greateſt Diſtance not above $\frac{1}{4}$ of a Degree (or a Hand's Breadth) from the Earth.

* As the Rotation of a Planet upon its *Axis* makes its *Day*, and the Revolution round the Orbit its *Year*; ſo the Revoluion of a *Moon* about a Planet makes its *Month*: Conſequently, if a Planet has no *Moon* ſurrounding it, it can have no *Month*, but only *Days* and *Years*.

Of the Planet JUPITER.

NEXT beyond *Mars* we find the refulgent Planet *Jupiter*; moving round the Sun in 11 *Years*, 314 *Days*, and 12 *Hours*, at the Diſtance of 424 Millions of Miles from him. By the *Teleſcope*, he is found to have ſomething like *Belts* ſurrounding his Body, near, and parallel to his *Equator*; in the loweſt is a large *Spot*, by which his Rotation on his *Axis* was diſcover'd to be in 9 *Hours* and 56 *Minutes*. This Planet, as well as *Mars* and *Saturn* is much nearer the Earth when in Oppoſition to the Sun, than in any other Situation in his Orbit. He is upwards of 81.000 Miles in Diameter, which makes him about 1000 Times bigger than our Earth; and has 4 *Satellites* or *Moons* revolving round him to enlighten him by Night, as our Moon does us, in a conſtant direct Order, as follows:

1	revolves in	1 D. 18 H.	at the Diſtance of	5	Semidiameters of *Jupiter*'s Body.
2		3 13		9	
3		7 3		15	
4		16 18		26	

By theſe Diſtances, the *Satellites* may be eaſily diſtinguiſhed from each other; and, by obſerving them with a *Teleſcope*, they may ſometimes be ſeen to caſt their *Shadows* upon his *Diſk*, when they are found between him and the Sun; and at other Times to be *eclips'd*, by falling into his Shadow as they paſs behind him.

By obſerving theſe *Eclipſes* of *Jupiter's Satellites*, it is found that *Light* is not inſtantly convey'd to us, but takes up 7 or 8 *Minutes* to travel from the *Sun* hither, which is about 81 Millions of Miles *.—And this vaſt Space Light paſſes through in ſo ſmall a Time, that the Velocity of its Motion cannot be eaſily conceiv'd by us.

By the *Eclipſes*, or *Immerſions* and *Emerſions* of theſe *Satellites*, or *Moons*, into and out of his Shadow, the Longitude of Places on our Globe may be found †.

*When the *Earth* is between the *Sun* and *Jupiter* theſe *Eclipſes* happen 7 *or* 8 *Minutes too ſoon*; and when the *Earth* is in the *oppoſite* Part of her Orbit, beyond the Sun, they happen as *much too late* than they ſhould by the beſt Calculations: The Reaſon is, becauſe the Light has further to go in the latter Caſe than the former, by the *Diameter* of the Earth's Orbit.

† Suppoſe I find, by Mr. *White's Ephemeris*, that the firſt *Satellite* of *Jupiter* will be *immers'd* into *Jupiter*'s Shadow at 8 o'Clock at Night, at *London*, on ſome certain Day; but, being at Sea, I obſerve, with a *Teleſcope*, the *Immerſion* to begin at 10 o'Clock the ſame Evening; the Difference, which is 2 Hours, turn'd in *Degrees*, allowing 15° for each Hour, ſhews that I am 30° to the *Eaſt*, becauſe the Time is *more* than at *London*. Had the Time been 2 Hours *leſs*, I ſhould have been 30° to the *Weſt*. By this Method, the *Mariners* are enabled to correct their *Reckoning* by theſe *Moons* of *Jupiter*, which were never heard of or ſeen till diſcover'd, with the Teleſcope, by *Galileo*, on the 7th of *January*, 1610.

Jupiter is a little more than 5 Times further from the Sun than the Earth is, conſequently his Diameter to that Planet is not a *fifth* Part of what it appears to us; and, therefore, his *Light* and *Heat* muſt be 25 Times leſs than ours.

Their *Year* is almoſt 12 of ours; but their *Days* and *Nights* are but ſhort, being about 5 Hours each, tho' their year is ſo long and tedious. As the *Axis* of this Planet inclines but little (if any) to the Plane of his Orbit, the *Days* and *Nights* muſt be nearly equal, and the *Inhabitants*, over the whole Globe, throughout the Year, will enjoy, as they do in *Mars*, a perpetual *Equinox*.

The *Satellites*, or *Moons*, to the *Inhabitants* there, will appear as large, perhaps, as our Moon does to us here; and they will have four Kinds of *Months*, whoſe Lengths are determined by the Revolutions of their *Moons*. In one of *Jupiter's Years*, which is nearly 12 of ours, there will be about 2407 of the *leaſt* Months:—1203 of the *ſecond* Kind:—601 of the *third*:—and 254 of the *fourth* or greateſt. A Year in *Jupiter* contains a great Number of their Days, not leſs than 108.200; but of the four Sorts of Months, the leaſt contains only $4\frac{1}{4}$ Days;—the *ſecond* about $8\frac{1}{2}$;—the *third* $17\frac{1}{2}$;—and the *greateſt* about 41 Days.

By the frequent *Eclipſes* of theſe four *Moons* *, the Navigators in *Jupiter* (if there are any) will be enabled to aſcertain their *Longitude* better than we can *here* upon our Globe by the Aſſiſtance of our (one) *Moon*.

The *Aſtronomers* in *Jupiter* will never ſee *Mercury*, *Venus*, the *Earth*, nor perhaps *Mars*, (unleſs in their Horizon ſometimes, at the Beginning and End of their *Twilight*) ſince from that Diſtance, they muſt appear to accompany the Sun, and riſe and ſet almoſt at the ſame Time with him. Nor will they, without better Glaſſes than ours, be able to know there are ſuch Worlds in Exiſtence. But they will ſee *Saturn* and his *five Moons*, and perhaps be able to diſcover the *Seaſons*, &c. in that Planet, ſomething better than we can. *Saturn* will alſo appear to them ſometimes *bigger* and ſometimes *leſs*, as *Mars* does to us, as he is nearer or further off in his Orbit from them, as is clear from a View of the *Syſtem* itſelf.

* The *Immerſions* of *Jupiter's Satellites* into his Shadow can only be ſeen when he is *Weſt* of the Sun, and their *Emerſions* when he is *Eaſt* of him. And when he is in exact *Oppoſition* to, or *Conjunction* with the Sun it will be in vain to look for either, becauſe his Shadow, lying perfectly behind his Body, is impoſſible to be ſeen at the Earth.—The ſame Appearances happen with Reſpect to the *Satellites* of *Saturn*.

Of the Planet SATURN.

SATURN is the higheſt Planet, and moſt remote in our Syſtem, being diſtant from the Sun 777 Millions of Miles. He makes his Periodical Revolution in 29 *Years*, 174 *Days*, and 6 *Hours*. His Diameter is about 67.860 Miles, therefore he is 600 Times bigger than the *Earth*, and *Half* as big as *Jupiter*. He is obſerv'd to have always a round full Face, but is of a dull Lead-colour. It is uncertain whether this Planet revolves upon his *Axis* or not, becauſe of his vaſt Diſtance from us. By viewing him through the *Teleſcope*, he is obſerved to have 5 *Satellites* moving round him, as he does round the Sun; and, according to the lateſt Diſcoveries, their Revolutions and Diſtances from him are as here ſet down:

1	revolves in	1 D. 21 H.	at the Diſtance of	4	Semidiameters of *Saturn*'s Body.
2		2 17		6	
3		4 12		12	
4		15 22		20	
5		79 7		59	

Thoſe *Moons* all move round the *Equator* of *Saturn*, and cut his Orbit at Angles of about 30 or 31 Degrees.

Beſides theſe 5 *Moons*, this Planet is found to have a ſurpriſing *Ring* encompaſſing him on every Side, but doth no where touch his Body. The Breadth of the *Ring* is about 21.000 Miles, and the Diſtance of it from *Saturn*, on every Part, much the ſame; ſo that, in ſome Situations, the Heavens may be diſtinctly ſeen between the *Ring* and his Body. It appears to be ſuſpended over the *Equator* of that Planet; is judg'd to be about 7 or 800 Miles thick. And its uſe is ſuppos'd to give *Light* and *Heat* to the People there *.

The *Ring* puts on many different Appearances to us at the Earth; for when *Saturn* is in 20° of *Sagitarius*, the *northern* Parts of the Planet being turn'd towards the Sun, making it *Summer* there, the *Ring* appears quite open.—When he is at 20° of *Piſces*, the *Ring* is quite *ſhut*, appearing only as a Line upon the Equator; then their Days and Nights are equal.—When he arrives to 20° of *Gemini*, the *ſouthern* Parts are turn'd towards the Sun, and the *Ring* appears *open* again. Now it is *Summer* to the *ſouthern* Inhabitants of that Planet.—When he is advanc'd to 20° of *Libra*, the *Ring* appears *ſhut* again, and the Sun being over their Equator, makes their Days and Nights equal, as in the oppoſite Part of his Orbit.

* This ſurpriſing *Phænomenon* of *Saturn's Ring* is a modern Diſcovery; neither were the *Satellites* of *Jupiter* or *Saturn* known to the Ancients. The *Moons* of *Jupiter* were firſt diſcover'd, as obſerv'd before, by the famous *Italian* Philoſopher *Galilæus*, with a Teleſcope, which he firſt invented in 1610. But Mr. *Hugens* firſt diſcover'd the *biggeſt* of *Saturn's Satellites*, which is the fourth, and the *Ring*, in 1665. The other four *Satellites* were diſcover'd by Mr. *Caſſini*, the French King's Aſtronomer, the 3d and 5th in 1671, 1672, and 1673; but the 1ſt and 2d were not ſeen till the Year 1684, with extraordinary Glaſſes of 100 and 200 Feet in Length.——All *Jupiter's Moons*,—one of *Saturn's*, the 4th,—and *Saturn's Ring*, may be ſeen with a *Refracting Teleſcope* of 8 or 10 Feet, or with a *Reflecting one* of 18 Inches or 2 Feet.

To the *Inhabitants* of this Planet, the Sun appears *ten* Times leſs than to thoſe on our Earth, as being *ten* Times further from him than we are; conſequently his *Light* and *Heat* will be almoſt 100 Times leſs*.—Cold and dreary Situation this, when compar'd to ours! But their *Natures*, no doubt, are ſuited to it; and our Light and Heat would be as intollerable to Them, as their Cold and Duſkineſs would be to Us.

Saturn's Year is almoſt 30 of ours; but the Length of the *Days* are wholly unknown to us: For we have not been able, on account of his vaſt Diſtance from us, to diſcover his Rotation on his *Axis*. There is, however, a vaſt *Inequality* in the *Length* of the *Days* in ſeveral Parts of this Planet, and as great Diverſity of *Summer* and *Winter* and other *Seaſons*, owing to the Inclination of the *Equator* to the Plane of *Saturn's Orbit*, which is about 30 or 31 Degrees.—Hence to the Inhabitants in the *Latitude* of 60 Degrees, their longeſt Day will have no Night, and, on the contrary, the longeſt Night will have no Day, juſt as with us under the *Artic Circle*.

The *Saturnians* (without better *Optics* than ours) ſee none of the Planets but *Jupiter*, and he appears to accompany the Sun, being never found, either before or after him, more than 34 or 35 Degrees. He therefore becomes their *Morning* and *Evening Star* by Turns, as *Venus* does to us. But they will ſee their own *five Moons*, perhaps, larger than ours, which will meaſure out to them five Kinds of *Months* of different Lengths. Theſe *Moons* will *increaſe* and *decreaſe*, come to the *new* and *full*, and frequently *eclipſe* each other and the Sun (as ours does here) as they revolve in their ſeveral Orbits round him.

The amazing *Ring* ſuſpended in their Sky, will caſt a Shadow (as the Sun moves Northward or Southward of their *Equator*) over vaſt Regions of *Saturn's Body*, which, removing from one Part to another, will cauſe great Changes in the Light and Darkneſs on that Planet. And it is very probable the Inhabitants may be ignorant of the Reaſon of theſe wonderful Varieties. For though we, here at the Earth, ſtand convenient to ſee it, and know it is owing to a mighty *Ring* ſurrounding his Body, yet it is not eaſy for them there to diſcover it. They muſt naturally imagine it to be in the Heavens, and have no Way of determining the Diſtance but from Obſervations made in different Latitudes. For tho' at their *Equator* it appears over their Heads, yet as they recede either Northwards or Southwards the *Ring* will appear lower, till at the Latitude of 60, perhaps, it will not be viſible. So that from thence to their *Poles*, the Inhabitants (if any) will be totally ignorant of that wonderful Phænomenon. Nor can they ſee it without taking a Journey on purpoſe.

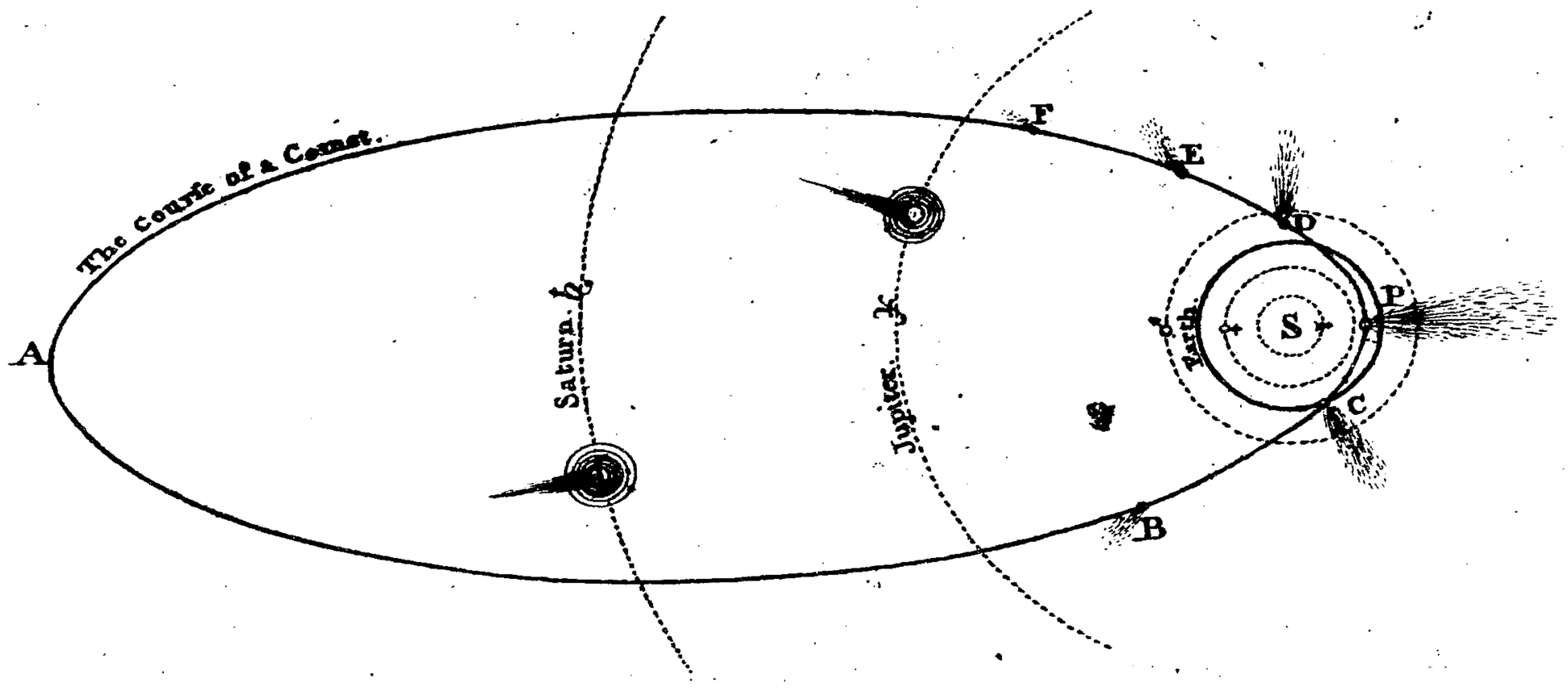
* The *Diameters* of the heavenly Bodies appear to *increaſe* and *decreaſe*, as we approach or recede from them, directly as the Diſtance themſelves; i. e. at *twice* the Diſtance they appear *Half* as large; at *thrice* the Diſtance *three* Times leſs.—But the Proportions of *Light* and *Heat* increaſe and decreaſe inverſely, as the Squares of thoſe Diſtances; i. e. at *twice* the Diſtance it is *four* Times leſs light and hot; at *three* Times the Diſtance, *nine* Times leſs.—And the *Bulk*, or ſolid Contents of thoſe Bodies are to each other directly as the Cubes of their Diameters; i. e if the Diameter of one Planet be *double* the Diameter of another, then the Bulk of the larger is *eight* Times greater than that of the ſmaller; if the Diameter be *three* Times greater, then it is *twenty-ſeven* Times bigger; and ſo of any other.

Of the COMETS.

BESIDES the *Planets* already treated of, there are other large Bodies belonging to our *Syſtem*, which are (as it were) a kind of temporary Planets; for they ſometimes make their Appearance in our Regions for a while, and then diſappear for a certain Space of Time, after which they return again. —Theſe wandering Bodies are call'd *Comets* or *Blazing Stars*.

The *Antients* thought them to be *Meteors* or *Exhalations*, ſet on fire in the *middle Regions* of the *Air*: But the *modern Aſtronomers* have found that they are large globular Bodies, moving in various Directions acroſs the *Syſtem*; and that their Orbits are not *circular*, like thoſe of the Planets, but very *eliptical*, or oval; and therefore, they are ſometimes at a moderate Diſtance from us; at other Times, they aſcend to vaſt Heights above *Saturn*, and ſo become inviſible, till they return into our Part of the Heavens again.

The Manner in which a *Comet* revolves in its Orbit round the *Sun*, and through the *Syſtem* is here delineated.



In this Scheme, S repreſents the *Sun*; A, B, C, P, D, E, F, the *eliptic* Orbit of a *Comet*; the black Circle C, P, D, the Orbit of the *Earth*; and the dotted Circles the Orbits of the reſt of the *Planets*. Now the *Comets* are found to revolve round the Sun in the ſame Manner as the Planets, differing from them only in the Form of their Orbits; for in the Planets their Orbs are nearly *circular*, but thoſe of the *Comets* are long *Eliptes*. And the greater the *Eliptes*, are the further will they ſtray from the Sun at one Time, and the nearer approach him at another: conſequently, they muſt ſuffer great and different Degrees of Heat and Cold. When a *Comet* is at A, it is at its greateſt Diſtance from the Sun, far beyond the Orbits of the moſt diſtant Planets; and, as they are not much larger than the *Moon*, (ſome few, perhaps, as large as the *Earth*) they remain hid from our Sight. But as they deſcend within the Syſtem, they become *viſible*, appearing, at firſt, like Stars of the ſmalleſt Magnitude; and as they approach the Sun they continually grow larger, till, at laſt, they exceed Stars of the largeſt Size.

When

When the *Comet* arrives at or about B, near the Orbit of *Mars*, it will be ſeen, perhaps, beginning to emit a ſmall lucid *fiery Tail*, from the Heat it then receives from the *Sun*. As it approaches nearer, the Heat increaſing, the *Tail* grows longer. At the *Perihelion*, at P, and a little beyond it, the *Tail* is longeſt of all. From thence, as the *Comet* continually aſcends, and the Heat diminiſhes, the *fiery Tail* begins to contract its Dimenſions, and grow leſs and leſs, till it becomes inviſible about F; after which it is ſeen no more, without a *Teleſcope*, till it returns again.

The *Comets* themſelves are ſuppos'd to be *hard*, *denſe*, *durable* Subſtances, like the reſt of the Planets; but their *Tails* ſeem to be owing to ſome *peculiar*, *rare*, and *luminous* Matter, in their Atmoſphere, which is eaſily excited by the Sun's Heat, and thrown off in fiery Vapours, always into the Regions oppoſite the Sun *. The *Magnitude* and *Length* of the *Tail*, depends chiefly on the Heat it receives from the Sun; whence, the nearer a *Comet* approaches the Sun, the longer is its *Tail*.

The *Tails* of the *Comets* are obſerv'd to put on various Appearances. For ſometimes they appear of a vaſt *Length*, growing *wider* and *thinner*, the farther they proceed from the Body of the *Comet*. At other Times they appear *ſhorter*, and with a *narrower* Termination, like a *Sword*. And ſometimes, the *Tail* ſeems to ſurround the *Comet*, with fine lucid Beams, like *Hair*. All which Variety of Aſpects ariſe from the Poſition of the *Tail* with reſpect to us at the Earth.

Some of the *Tails*, near their Extremities, are ſo very fine and tranſparent that the fix'd Stars may be diſtinctly ſeen through them: And their Lengths become ſometimes ſo amazing, as to take up more than 40 Degrees in the Heavens; which, conſidering their Diſtances at that Time, cannot meaſure leſs than 70 or 80 Millions of Miles.

The *Comets* moving in very long *elliptical* Orbits, and becoming viſible to us only through the ſmall Part of their Courſe near the Sun, and remaining loſt, as it were, and unknown to us through their immenſe Journeys beyond *Saturn*, their *Periods* cannot be ſo eaſily determin'd as thoſe of the *Planets*. And when a *Comet* does return, we are not certain it is the ſame, but by comparing its Direction through the Heavens with ſome one that has appear'd there before.

By this Method, we know that the Period of the *Comet* which appear'd in 1680 is 575 Years, becauſe one of the ſame Kind was ſeen in the Year 1106; and once before about the Year 532; and alſo 44 Years before *Chriſt*. This *Comet*, at the time it appear'd laſt, came ſo near the Sun, as to be within *one ſixth Part* of the Sun's Diameter from the Sun's Body; conſequently, it muſt receive a Degree of Heat 28.000 Times hotter than our Earth in *Summer*; which is about 2000 Times hotter than *red-hot Iron*.——This is a Proof that the Bodies of the *Comets* are extremely *fix'd* and *durable*, elſe they muſt be totally diſſipated and conſum'd by ſuch an intenſe Heat.

* As to the Cauſe of the Aſcent of the *Tail*, *Kepler* aſcribes it to the Rarefaction of the Comet's Atmoſphere by the Heat of the Sun, and the impulſive Force of the Sun's Beams, carrying along with the Matter of the Comet's *Tail*; which alſo accounts, at the ſame Time, for the Direction or Poſition of the *Tail*, which is always towards the Parts oppoſite to the Sun.

The

The Revolution of another *Comet*, which appear'd in 1682, is ſuppos'd to be 75½ Years, becauſe ſuch an one was ſeen in 1607, 1531, and 1456. Its Return was expected in 1758, but was not ſeen till the Beginning of 1759, at which Time it was viſible in many Parts of *America*; and obſerv'd to be aſcending back from the Center of the Syſtem. This *Comet*, at its neareſt Approach to the Sun came within the Orbit of *Venus*, and receiv'd a Degree of Heat greater than that of *boiling Water*.

Another *Comet*, which was ſeen in 1661, and before in 1532, will probably return again in the year 1789, making its Tour round the Sun in 129 Years.

The *Number* of the *Comets* is imagin'd to be about 24 or 25; but theſe Periods are all that are certainly known to our Aſtronomers at preſent; and are what we muſt content ourſelves with, till further Obſervations and Diſcoveries are made.

Theſe amazing Bodies, in their Journies to and from the Sun, move in all manner of *Directions* acroſs the Orbits of the Planets *. For ſome revolve from *Weſt* to *Eaſt*; others, on the contrary, from *Eaſt to Weſt*: Some, again, move from *North* to *South*; and others, nearly *perpendicular* to the Plane of the Planets Orbits. And as they are ſometimes burning with intenſe Heat in the Neigbourhood of the Sun, and at other Times ſcarcely receiving any friendly Influences from him; it cannot be ſuppos'd that they are Places of Habitation; and deſign'd for Animals and Vegetables, as the Planets are.

What then may be the *Uſes* of theſe *wonderful Bodies* and their *fiery Tails* to the Syſtem, is, at preſent, only conjectural.——Some have ſuppos'd, that in each Revolution they accede nearer the Sun, till at laſt, falling upon his Surface, they ſupply him with freſh *Fuel*.——Others have thought, that their *Tails* are fine *volatile Spirits* excited by the Heat of the Sun, and diſſipated through the Syſtem, to refreſh the *Atmoſpheres* of the Planets, and ſupply them with thoſe *vivifying Spirits* ſo neceſſary to ſuſtain the Life of *Animals* and *Vegetables* there.——Some, again, have look'd on them, on Account of the exceſſive *Heat* they receive near the Sun, and the intenſe *Cold* they muſt ſuffer at their greateſt Diſtance from him, to be proper *Receptions* for the Habitation of the *Damn'd*.——Whilſt others have concluded them, with greater Probability, to be the *Executioners* of GOD's Vengence on ſinful *Worlds*; by ſcattering their *baneful Influences* on the Inhabitants, or daſhing the *Planet* to Pieces, and reducing it to its *chaotic State* again.

The learned Mr. *Whiſton* has made it very probable, that a *Comet* paſſing by our *Earth*, in its Deſcent towards the Sun, and involving us in its *Tail*, in the Days of *Noah*, was the Cauſe of the *Deluge*; and that another, ſometime hence, in its Aſcent from the Sun, after having been thoroughly *ignited* there, may bring about the *General Conflagration*.

* As many of the Comets are obſerv'd to revolve in a *Direction* contrary to the Planets, and with a great and regular *Velocity*; we are aſſur'd there can be no *ſolid Orbs*, as the *Antients* ſuppos'd; nor *Vortices*, or *Whirlpools*, of ſubtle Matter in the Heavens to carry the Planets round the Sun, as the *Carteſians* imagin'd. For if there were ſuch *Circulations* of etherial or ſubtle Matter, the Comets would, when they enter'd into the *Regions* of the Planets, be neceſſarily driven from their Courſe by the rapid Motion of ſuch a *mighty Torrent*, and be carried the ſame Way with the neighbouring Bodies. But, as ocular Demonſtration aſſures us that no ſuch Thing happens to the Comets, but that they preſerve their Motions with the greateſt Freedom, as in a perfect Void or *Vacuum*; we muſt acknowledge, that in the Heavens there is no Reſiſtance, and conſequently, no *Medium*, or *Fluid*, which can have any ſenſible *Denſity*; but that all the Spaces *between* and *beyond* the *Planetary Syſtem* are an immenſe *Vacuity*, admitting nothing but the Rays of *Light*, unleſs near the *Atmoſpheres* of the Comets and Planets; and, conſequently, that all Solutions of the *Phænomena* of the *Heavens*, depending on the Suppoſition of ſuch a *ſubtle Matter*, are *falſe*, and contrary to the evident State of our *Syſtem*.

Of

Of the FIX'D STARS.

AT a vaſt Diſtance beyond the Orbits of all the *Planets* and *Comets*, we behold, in a clear Night, the azure Concave ſtudded over with *Stars* of different *Luſtres* and *Magnitudes*. And becauſe they retain the ſame Diſtances and Situation with reſpect to each other at all Times, they are juſtly call'd *fix'd Stars*, to diſtinguiſh them from the *Planets*, which are continually wandering from Place to Place. Their *Diſtance* from us muſt be immenſely great, ſince there is no viſible Alteration in their Poſitions, with reſpect to each other, when viewed from different Parts of the Earth's Orbit; conſequently, the *whole Orbit* of the Earth, which is 162 *Millions* of Miles in *Diameter*, is but a Point in Compariſon to it.

Aſtronomers have computed the Diſtance of the *greateſt*, and conſequently the *neareſt fix'd Star*, to be about *Two Millions of Millions* of Miles *; which is ſo very great, that a *Cannon-ball* would ſcarcely arrive thither in 700.000 Years, though it ſhould roll on with the ſame *Velocity* it receiv'd at the Mouth of the Cannon. And it is very probable that they are ſituate as far from one another.

From the *fix'd Stars* being viſible at ſuch an immenſe Diſtance, we conclude that they do not ſhine with a *reflected* or *borrow'd Light*, like the *Planets* which are near us, but with their own *native Glory*, which they muſt have in themſelves, like our Sun; and, therefore, are Bodies ſimilar to him. And were we to be remov'd as near the *fix'd Stars* as we are to our *Sun*, they would appear as large, perhaps, as he does; and our *Sun*, beheld from thence, would appear a *twinkling Star* among the Reſt.

The *Stars*, as they appear of different *Sizes*, are divided, for Diſtinction's ſake, into Six different *Magnitudes* or Claſſes; of which the *largeſt* and *brighteſt* are call'd of the *firſt Magnitude*. Next theſe, are the *ſecond Magnitude*; and the next Size, are Stars of the *third Magnitude*; and ſo on to the *ſixth*, which are the ſmalleſt that can be ſeen by the naked Eye in the cleareſt Night; but it is ſeldom that we can ſee thoſe that are ſmaller than the *fourth* Magnitude.

Several *Catalogues* have been made of the *fix'd Stars*: The *firſt* was by *Hipparchus*, the *Rhodian*, on ſeeing a New Star ‡ in the Heavens, about 120 Years before Chriſt; his Catalogue contain'd 1022 Stars. After him, *Ptolomy* enlarg'd that Catalogue to 1026. *Ulug Beigh*, the Grandſon of *Tamerlane* the Great, made a Catalogue of 1017 Stars. *Tycho Brahe* determin'd the Places

* Mr. *Hugens* ſuppoſing the *fix'd Stars* of the ſame Magnitude with our *Sun*, found that *Syrius*, or the *Great Dog*, which is the *largeſt*, and therefore, very probably, the *neareſt*, appear'd about 27.000 Times leſs than the *Sun*: His Diſtance muſt therefore be 27.000 Times as far; that is, upwards of 2 *Millions of Millions* of Miles.——Dr. *Bradley*, from a very ſubtle Calculation, makes the Diſtance ſtill greater.

† The *Twinkling* of the *fixed Stars* is owing to the exceeding Smallneſs of their apparent *Diameters*, occaſion'd by their immenſe Diſtance; ſo that every little Particle of *Duſt* that floats in the Air, when it comes between the *Star* and the *Eye* will *eclipſe* it; and as the Air is full of various Kinds of Particles, ſome of them are conſtantly paſſing between the *Eye* and the *Star*, and conſequently cauſe the *Star* to *twinkle*.

‡ It is ſeldom we are favour'd with the Appearance of a *New Star*; but at preſent there is a wonderful *one* in the *Neck* of the *Whale*, which is obſerved to appear and diſappear periodically, its *Period* being *Seven* Revolutions in *Six* Years.

of 777 *fix'd Stars*, and reduc'd them to a Catalogue. *Kepler*'s Catalogue contain'd 1163. The Prince of *Heſſe*'s Catalogue was of 400 Stars. *Ricciolus* enlarg'd *Kepler*'s Catalogue to 1468. *Bayerus* is ſaid to have deſcrib'd the Places of 1725, and mark'd each Star with a Letter of the *Greek* Alphabet: The biggeſt Star in each Conſtellation being denoted by the *firſt* Letter; the next Size by the *ſecond*; and ſo on to the ſmalleſt. After him, *Hevelius*, of *Dantzick*, compos'd a new Catalogue of 1888. But the largeſt and beſt is that of Mr. *Flamſtead*'s, which contains about 3000; of which Number it is ſeldom that a good Eye can ſee more than 100 together: And Mr. *Flamſtead* himſelf aſſerts, that the naked Eye can diſcover *no more than* 384 *Stars*, in the cleareſt Night, in both *Hemiſpheres*. But, with an ordinary *Teleſcope*, we can diſcover, in ſome Parts of the Heavens, 10 Times as many as were viſible to the Eye before; ſo that we have Reaſon to believe, that only the *all-wiſe* and *powerful Being*, who fram'd them, is able to *tell the real Number of the Stars, and call them by their Names.*

The *ancient Aſtronomers*, the better to diſtinguiſh and deſcribe the *fix'd Stars* from one another, have drawn them upon *Globes* and *Maps*, in 48 *Images* or Parcels, as of *Men*, *Lions*, *Bears*, *Triangles*, *Crowns*, &c. whence it comes to paſs, that every *Star* has a Name from that Part of the Image it is ſituate in; as, the *Bull's Eye*, *Lion's Heart*, *Orion's Belt*, &c.——Some *modern Aſtronomers* have added 29 *Conſtellations* more, which were unknown to the *Antients*; and which are form'd from thoſe *Stars* lying between the other *Conſtellations*; and are depicted on the Globe in a *fainter* Character.

The *Names* of the ſeveral *Conſtellations*, and the Number of *Stars* viſible in each, you will find upon the *Cæleſtial Globe*, laid down exactly correſponding with thoſe in the Heavens.

The *Conſtellations* on the *North Side* of the *Ecliptic* or *Zodiac*, are 34.

The *Little Bear*, *Great Bear*, *Boötes*, *Crown*, *Dragon*, *Cæphus*, *Hercules*, *Harp*, *Swan*, *Perſeus*, *Andromeda*, *Caſſiopeia*, *Auriga*, *Lynx*, *Little Lion*, *Greyhounds*, *Charles's Heart*, *Lizard*, *Serpent-holder*, *Serpent*, *Dart*, *Camelopardus*, *Berenice's Hair*, *Mount Menalus*, *Eagle*, *Gooſe*, *Fox*, *Antinoüs*, *Dolphin*, *Little Horſe*, *Pegaſus*, *Great Triangle*, *Little Triangle*, and *Fly*.

The 12 *Signs*, or *Conſtellations*, of the *Ecliptic*, or *Zodiac*, through which the Planets all move in their yearly Revolutions, are,

♈ *Ram*, ♉ *Bull*, ♊ *Twins*, ♋ *Crab*, ♌ *Lion*, ♍ *Virgin*, ♎ *Scales*, ♏ *Scorpion*, ♐ *Archer*, ♑ *Goat*, ♒ *Water-bearer*, ♓ *Fiſhes*.

The *Conſtellations* on the *South Side* of the *Ecliptic* or *Zodiac*, are 31.

The *Whale*, *Orion*, *River Po*, *Hare*, *Great Dog*, *Little Dog*, *Ship*, *Crow*, *Hydra*, *Cup*, *Centaur*, *Wolf*, *Altar*, *South Crown*, *South Fiſh*, *Phœnix*, *Crane*, *Unicorn*, *Indian*, *Peacock*, *Dove*, *Chamælion*, *Bird of Paradiſe*, *Indian Fly*, *Flying Fiſh*, *Sword Fiſh*, *South Triangle*, *Oak*, *Toucan*, *Hydrus*, and *the Croſs*.

Beſides

Beſides theſe *Conſtellations*, there is a *whitiſh Tract* in the Heavens, call'd the *Milky Way*, paſſing round thro' *Auriga*, ſouthward, by the *Twins*, the *Great Dog*, the *Ship*, and returns by the *Scorpion*, *Archer*, *Serpent-bearer*, *Eagle*, *Swan*, *Caſſiopeia*, and *Perſeus*, back to *Auriga* again. This *Path* is of unequal Breadth, and in ſome Parts, dividing itſelf, becomes *double*. It is ſuppos'd to be form'd by an infinite Number of ſmall *Stars*, viſible only through the *Teleſcope*, which, combining their Light in thoſe Parts, cauſe that *ſhining Whiteneſs*. We have a fine View of it, in the *Evenings*, in the Months of *February* and *Auguſt*. There are ſeveral duſky or cloudy *Spots* in the Heavens, (particularly one in the *Crab*) which are ſuppoſed to be owing to the ſame Cauſe as the *Milky Way* *.

Some have wonder'd at the great *Irregularity* which appears in the Diſpoſition of the *fix'd Stars*; but that Irregularity is of the *greateſt Uſe*: For, from thence it is the Heavens become diviſible into *Signs* and *Conſtellations*, which a regular Situation would have render'd impoſſible. By this means we are enabled to aſcertain, at all Times, the *Revolutions* and *Places* of the *Planets*, and to render their Motions ſerviceable to us here.

The *riſing* and *ſetting* of the *fix'd Stars*, their apparent Motions every Night to the *Weſt*, is owing to the *Earth's* Rotation upon its *Axis*, every Day, toward the *Eaſt*. And our ſeeing different *Stars*, at different Seaſons of the Year, is owing to the *Earth's Revolution* in its Orbit round the Sun, as delineated at Page 8.

The whole Body of the *fix'd Stars* appears to have a ſlow progreſſive Motion † (parallel to the *Ecliptic*) towards the *Eaſt*, of about 50″ yearly, *i. e.* 1° in 70 Years; conſequently, they do not complete *one Revolution* in leſs than 25.920 *Years*; after which Time they all return to the ſame Places again. This long *Period* was call'd the *Great Year*, and the *antients* imagin'd that when it was finiſh'd all Things would begin anew, and return in the ſame *Order* and *Manner* as before.

* Some of the largeſt Stars have particular Names given them; as *Aldebaran*, a large Star in the Bull's Eye;—*Caſtor* and *Pollux*, two remarkable Stars in the Twins;—*Regulus* and *Deneb*, both of the firſt Magnitude, the former in the Lion's Heart, the other in his Tail;—*Syrius*, a glorious Star in the Jaws of the Great Dog;—with many others, which you will find inſerted in their proper Place on the *cæleſtial Globe*.——The *Ancients* plac'd theſe Figures in the Heavens, either to commemorate the Deeds of ſome great Men, or ſome remarkable Exploit or Action; or elſe took them from the Fables of their *Religion*, &c. And the *Moderns* retain them, to avoid the Confuſion which would ariſe by making new ones, when they compare the modern Obſervations with the old Ones.—Thoſe Stars which lie between the ſeveral Conſtellations, not cover'd by any Figure, are call'd *unform'd Stars*.——The Diviſion of the Stars into Images and Figures is of great Antiquity, probably as old as *Aſtronomy* itſelf. For in the moſt antient Book of *Job* we read of the Conſtellations *Orion*, *Arcturus*, the *Pleiades*, and *Mazzaroth*; which laſt is ſuppos'd to expreſs the 12 Signs of the *Zodiac*.

† This Motion of the fix'd Stars is not *real* (like that in the Planets) but *apparent* only; being caus'd by the ſpheroidical Figure of the Earth, turning its *Axis* continually, by little and little, (from its Paralleliſm) towards the *Weſt*; which, conſequently, muſt make all the Stars appear to advance forward juſt as much towards the *Eaſt*.

Of the IMMENSITY of the UNIVERSE.

THE *Ancients* look'd upon the azure *Firmament* of the fix'd Stars to be the Boundary of the Univerſe, and that they were plac'd (as it were) in a ſolid *Arch*, at an equal Diſtance from us. But the *Moderns*, ſince the Invention of *Teleſcopes*, have ſuppos'd, and with greater Probability, that every *fix'd Star* is a *Sun* ſurrounded with *Planets* and *Moons* like our own. Which ſeveral *Syſtems* of the *fix'd Stars*, as they are at great and ſufficient Diſtances from the *Sun* and *Us*, ſo are they conceiv'd to be at proper and regular Diſtances from one another. Hence it is that the *fix'd Stars*, which though perhaps nearly of the ſame Size, appear to us of *different Magnitudes*;—the neareſt largeſt, thoſe further off, leſs and leſs.

To ſuppoſe theſe glorious Bodies were all created only for our Uſe;—purely to ſcatter over our Globe a little dim Light in a Winter's Night, is forming very ſlender *Ideas* of the *Divine Wiſdom*; ſince one *Luminary* depoſited at a proper Diſtance, would have been more beneficial, on that Account, than all their twinkling Rays united together.—Far more *rational*, as well as more to the *Glory of God*, is the Suppoſition that every *fix'd Star* is a *Sun*, ſurrounded with a *Syſtem* of *Planets*, which, at *different Diſtances* and in *different Periods* of Time, perform their *diurnal* and *annual* Revolutions round him.

In what Part of the Univerſe our *Syſtem* is plac'd;—whether in the *Center*, or nearer the *Extremities*;—or whether there are not nobler Syſtems ſomewhere through the amazing Workmanſhip of God, are *Problems* beyond our Abilities at preſent to determine *. For, by Reaſon of their vaſt Diſtances, our beſt *Teleſcopes* are found too weak to diſcover actual Globes revolving round their reſpective *Suns*, yet we can clearly enough diſcover that the *fix'd Stars* have in themſelves the Nature of *Suns*; and that ſome Things, ſimilar to Planets, ſometimes appear and diſappear in the Regions or Neighbourhood of thoſe Bodies.

What an amazing Scene does this diſplay to us!—What an inconceivable *Vaſtneſs* and *Magnificence* of *Power* and *Wiſdom* does ſuch a Frame unfold!—*Suns* beyond *Suns*, to our weak Senſe indefinitely diſtant from each other, and *Myriads* of Manſions, like our own, peopling Infinity, all ſubject to the Creators Will!—An Univerſe of Worlds, all deck'd with *Mountains*, *Lakes*, and *Seas*; with *Rivers*, *Trees*, and *Animals*, various as the Globes they inhabit!—All the Produce of *indulgent Wiſdom* to cheer Infinity with endleſs Beings, to whom his *Omnipotence* may give a *variegated eternal Life*.

* The Rev. Mr. *Hervey*, in his *Meditations*, has given a moſt magnificent Deſcription of the *Univerſe*. "Could we (ſays that Author) wing our Way to the higheſt apparent Star, we ſhould there "ſee other Skies expanded, other *Suns* that diſtribute their inexhauſtible Beams of Day, other Stars "that gild the alternate Night, and other, perhaps, nobler Syſtems eſtabliſh'd; eſtabliſh'd in "unknown Profuſion through the boundleſs Dimenſions of Space. Nor does the Dominions of the "great *Sovereign* end there: Even at the End of this vaſt Tour, we ſhou'd find ourſelves advanc'd "no further than the Frontiers of Creation, arriv'd only at the *Suburbs* of the great *Jehovah*'s King-"dom."

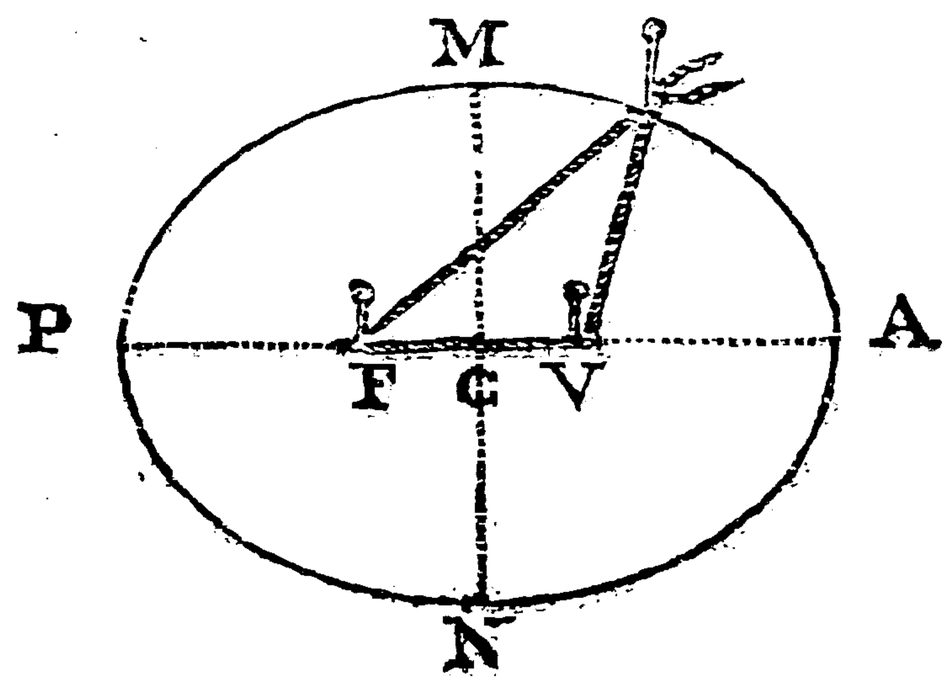
Of the true Figure of the Planets Orbits:

WITH THE

Nature of their *Motions* in them; and their *Situations* with reſpect to the *Ecliptic*; alſo their *Aphelions*, *Perihelions*, *Inclinations*, and *Nodes*.

THE *Planets* do not revolve round the *Sun* in Orbits exactly *circular*, but a little *elliptical*; conſequently, they are ſometimes a little *nearer*, and ſometimes a little *further* from him. For the better underſtanding their Motion, it will be neceſſary to ſhew how to delineate an *Ellipſis*; which the Learner may take as follows.

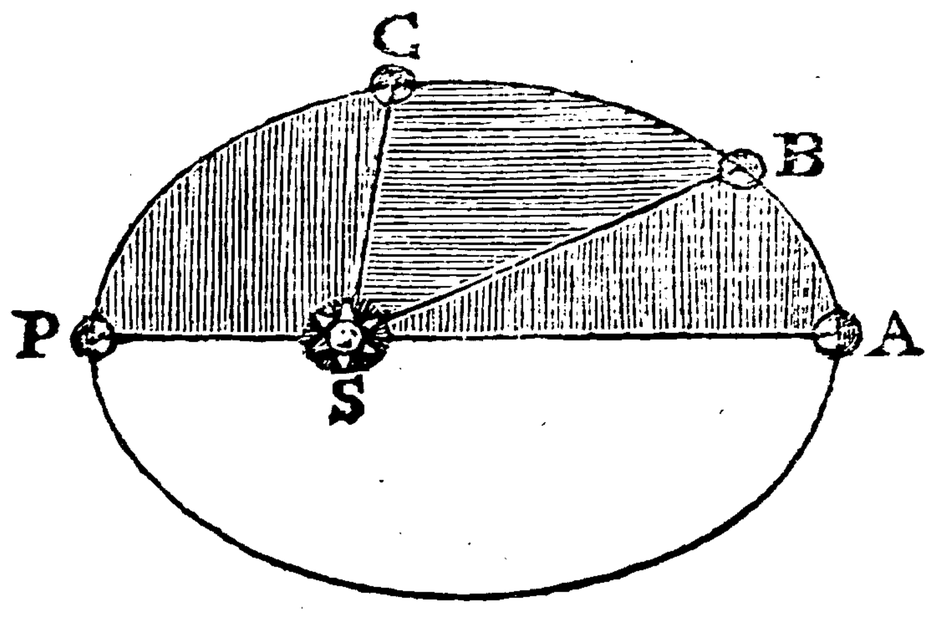
Fix upright (upon any Plane) two Pins, as at F and V; round theſe tie a Thread, *ſomething longer* than their Diſtance from each other; then apply, in the Doubling of the Thread, another Pin, or Pencil, ſo as to keep the Thread properly ſtrain'd; and in that Manner carrying the Pin round, with a ſteady Hand, the Point of it will deſcribe a Curve we call an *Ellipſis*. — The nearer the Pins are together the more circular will the Figure be; ſo that when they unite, or ſtand together, the Thread will deſcribe a perfect Circle. —— The two Points, F and V, where the Pins ſtand, are call'd the two *Focuſſes* of the *Ellipſis*. The Line PA, going through the the *Focuſſes*, from one End to the other, is called the *longer Diameter*; and the Line MN, cutting the former in the Middle between the *Focuſſes*, is the *ſhorter Diameter*. The Point where theſe two Diameters interſect each other at C, is the *Center* of the *Ellipſis*.



Now each of the *primary Planets* in their yearly Revolutions round the *Sun*, deſcribe a Line of this kind *: For the *Sun* is not plac'd in the Middle of their Orbs, at C, but in one of the *Focuſſes*. —— Suppoſe the *Sun* to be plac'd at F; then will the *Planet*, when at P. be *neareſt* the *Sun*, and at A *furtheſt* from him. The Point P is call'd the *Perihelion* of a *Planet*; and A the *Aphelion*: And the Points M and N are the *middle* or *mean Diſtances*, becauſe the Diſtances FM and FN are a *mean* between FP the *leaſt*, and FA the *greateſt Diſtance*. The Diſtance FC, or CV, is call'd the *Eccentricity*, which is different in the different Orbits of the Planets, but in all of them it is ſo little, that in all ſmall Schemes made to repreſent their Orbits, it is needleſs (and almoſt impoſſible) to expreſs it. But, in the Orbits of the *Comets*, the *Eccentricity* is very conſiderable; for their Orbs are very long *Ellipſes*, and the *Focuſſes* at vaſt Diſtances from one another.

* The Way we came to know that the Orbit of the *Earth* is *elliptical*, is, becauſe the *Sun* appears of different Sizes at different times of the Year. In *June*, his Diameter is about 31¾ Minutes; but in *December*, 32¾ Minutes. The *Earth* alſo is found to move ſlower in the *former* Caſe than in the *latter*. It muſt, therefore, neceſſarily follow, that we are further from the *Sun* in *Summer* than in *Winter*, and that our Orbit muſt be *elliptical*.

As the *Planets* are ſometimes *nearer*, and ſometimes *further off* the *Sun*, the Velocity of their Motions muſt be different in different Parts of their Orbits. —For, when the *Planet* is at A, in its *Aphelion*, (or moſt diſtant Part of its Orbit) the *Sun*'s Action upon it will be leſs than in any other Part; conſequently, its Motion *there* will be the *ſloweſt*. But, as the *Planet* proceeds from A towards P, in the Figure below, its Motion (as it is continually coming nearer the *Sun*) will be continually *accelerating*, or *increaſing*, till it arrives at P; where the *Sun* acting upon it with the greateſt *Force*, the *Planet* will move with the greateſt *Swiftneſs*. And as it revolves from P, its *Perihelion*, it will ſlacken, by little and little, its Pace, as it recedes further from the *Sun*, till it comes to A, where the Motion is *ſloweſt* of all.—Now, ſince the Motion of the *Planets* is ſo *unequal*, the *Arches* thro' which they paſs in certain given Times, muſt be ſo too.



Though the *Planets* move through *unequal* Spaces in *equal* Times, yet it has been diſcover'd, that the *triangular* Spaces within the Orbit, made by Rays drawn from the *Sun* to the *Planet* will be always *equal* in *equal* Times. —For, if the Times in which the *Planet* moves from A to B, and from B to C, and from C to P, be *equal* to each other, as, ſuppoſe, a *Day*, a *Week*, a *Month*, &c. the *Areas*, or *triangular* Spaces, ASB, BSC, and CSP, deſcrib'd in thoſe *equal* Times, (by Lines drawn from the *Planet* to the *Sun*) will alſo be *equal* among themſelves, or to one another.—It muſt therefore follow, that when the *Planet* is near its *Perihelion*, its Motion will be ſo much *ſwifter* than in the *Aphelion*, as the Line PS is ſhorter than AS; becauſe the Line PS multiply'd into the Arch PC, muſt be equal (by this ſurpriſing Law) to the Line SA multiply'd into the Arch BA.

Though the *Planets* revolve at different Diſtances, one beyond the other, round the *Equatorial* Parts, or *Middle* of the *Sun*, yet they do not all move exactly in the ſame *Plane*; but have their Orbs a little *inclin'd* to one another.—Thus, ſuppoſe we make the Plane of the *Earth*'s Orbit the Standard, then we ſhall find that the Orbits of the reſt of the *Planets* cut it in *two* oppoſite Parts; having one Half of their Orb above, the other Half below it. The Points where the Orbits cut the Plane of the Earth's Orbit, are call'd the *Nodes* of the *Planets*. No *Planet* can therefore be in the *Ecliptic* (i. e. exactly level with the Plane of the *Earth*'s Orb) but when it is in the *Nodes*: In all other Parts they are either a little *above* or a little *below* it. When they are *above* it, they are ſaid to have *North Latitude*; when *below* it, *South Latitude*; which *Latitude* is never but a few Degrees. For when the *Planets* are at the greateſt Diſtance *above* or *below* the Plane of the *Earth*'s Orbit, (which always happens when they are in the Middle between the *Nodes*) the Diſtance of *Saturn* is not more than $2\frac{1}{2}$ Degrees; of *Jupiter*, $1\frac{1}{4}$ Degree; of *Mars*, $1\frac{3}{4}$ Degrees; of *Venus*, $3\frac{1}{2}$ Degrees; and of *Mercury*, 7 Degrees.—This *Inclination* ſeems to have been given the *Planets* to prevent their too frequently *eclipſing* one another; which they would have done every Revolution, had not this Divine Contrivance taken Place.

To

To give the Learner a better Idea of the various *Properties* and *Affections* of the *Planets* mentioned in the foregoing Courſe of this Work, I have brought them all into one View in the following TABLE.

Planets Names	Saturn	Jupiter	Mars	Earth	Venus	Mercury
Characters or *Marks*	♄	♃	♂	⊖	♀	☿
Diameters in Miles	67870	81155	4444	7964	7906	2460
Circumfer. of Bodies	213112	254908	13960	25020	24823	7724
Mean Diſtance from the *Sun*, in Miles	777000000	424000000	123000000	81000000	59000000	32000000
Periods, or *Length* of their *Years*	$10759^d\ 6^h\ 36'$	$4332^d\ 12^h\ 20'$	$686^d\ 23^h\ 27'$	$365^d\ 6^h\ 9'$	$224^d\ 16^h\ 49'$	$87^d\ 23^h\ 16'$
Diurnal Motion, or *Length* of their *Days*	unknown	$0^d\ 9^h\ 56'$	$1^d\ 00^h\ 40'$	$0^d\ 23^h\ 56'$	$0^d\ 23^h\ 00'$	unknown
Moons, or *Satellites*	5	4	unknown	1	ſuppos'd 1	not known
Proport. of *Light* and *Heat*, ſuppoſing the Light at the Earth 1	$\frac{1}{90}$	$\frac{1}{27}$	$\frac{4}{10}$	1	2	7
Inclination of their *Orbits* to the Ecliptic	2° 30′ 00″	1° 20′ 00″	1° 52′ 00″	0° 00′ 00″	3° 24′ 00″	6° 54′ 00″
Inclination of their *Axes* to their Orbits	30° 00′ 00″	little if any	little if any	23° 29′ 00″	little if any	unknown
Daily mean Motion in the Ecliptic	0° 02′ 00″	0° 04′ 59″	0° 31′ 27″	0° 59′ 08″	1° 36′ 08″	4° 05′ 32″
Greateſt appar. *Diam.*	0′ 19″ 40‴	0′ 24″ 12‴	0′ 20″ 50‴	32′ 47″ Sun	1′ 05″ 58‴	0′ 11″ 48‴
Leaſt apparent *Diam.*	0′ 14″ 11‴	0′ 14″ 36‴	0′ 12″ 46‴	31′ 40″ Sun	0′ 09″ 34‴	0′ 04″ 04‴
Eccentricity of Orbits, ſuppoſing Diſt. 1000	55	48	93	17	7	210
Place of *Aphelion*, the *Perihelion* oppoſite	♒ 0° 06′	♎ 10° 58′	♍ 1° 55′	♒ 8° 57′	♒ 7° 37′	♐ 13° 45′
Place of *Aſcend. Node*, *Deſcending* oppoſite	♋ 21° 26′	♋ 8° 32′	♉ 18° 09′	* * *	♊ 14° 34′	♉ 15° 45′
Elongation of *Inferior*, and *Parallax* of *Superior* Planets	6° 00′	11° 05′	41° 00′	* * *	46° 41′	22° 46′
Colours of the Planets	dim lead-colr.	ſplendid white	fiery red	* * *	yelloviſh wh.	ſparklg. red
Motion in an Hour, in Miles	18000	24000	45000	56000	70000	100000

The *Diſtance* of the *Moon* from the Earth is about 240.000 Miles.—She revolves round her Orbit, from *Sun* to *Sun*, in $29^d\ 12^h\ 44'$.—Her *Diameter* is 2170, and her *Circumference* 6815 Miles.—The *Length* of their *Day* is almoſt 30 of ours, and their *Year* the ſame as with us.—She moves in one Hour 2200 Miles.—Greateſt *apparent Diameter* 33′ 20″, and *leaſt* 29′ 48″.—The *Place* of the *Nodes* is always varying, revolving round the Ecliptic in $18^y\ 224^d\ 4^h$.—Her *Eccentricity* is 55 Parts in 1000.——The *Moons* of *Jupiter* and *Saturn* are ſuppos'd to be as large as our Moon, or ſome of the Inferior Planets.

Of all the *Comets*, the *Periods*, *Diſtances*, &c. of only *Three* of them are known.

1ſt Comet	revolves	Years 75	at the Rate	Miles 13000	in an Hour.	Greateſt Diſtance from Sun	Miles. 2916 Mill.	Leaſt Diſt.	Miles	48000000
2d Comet	in	129	of	9000			4050 Mill.			40000000
3d Comet		575		6000			11200 Mill.			500000

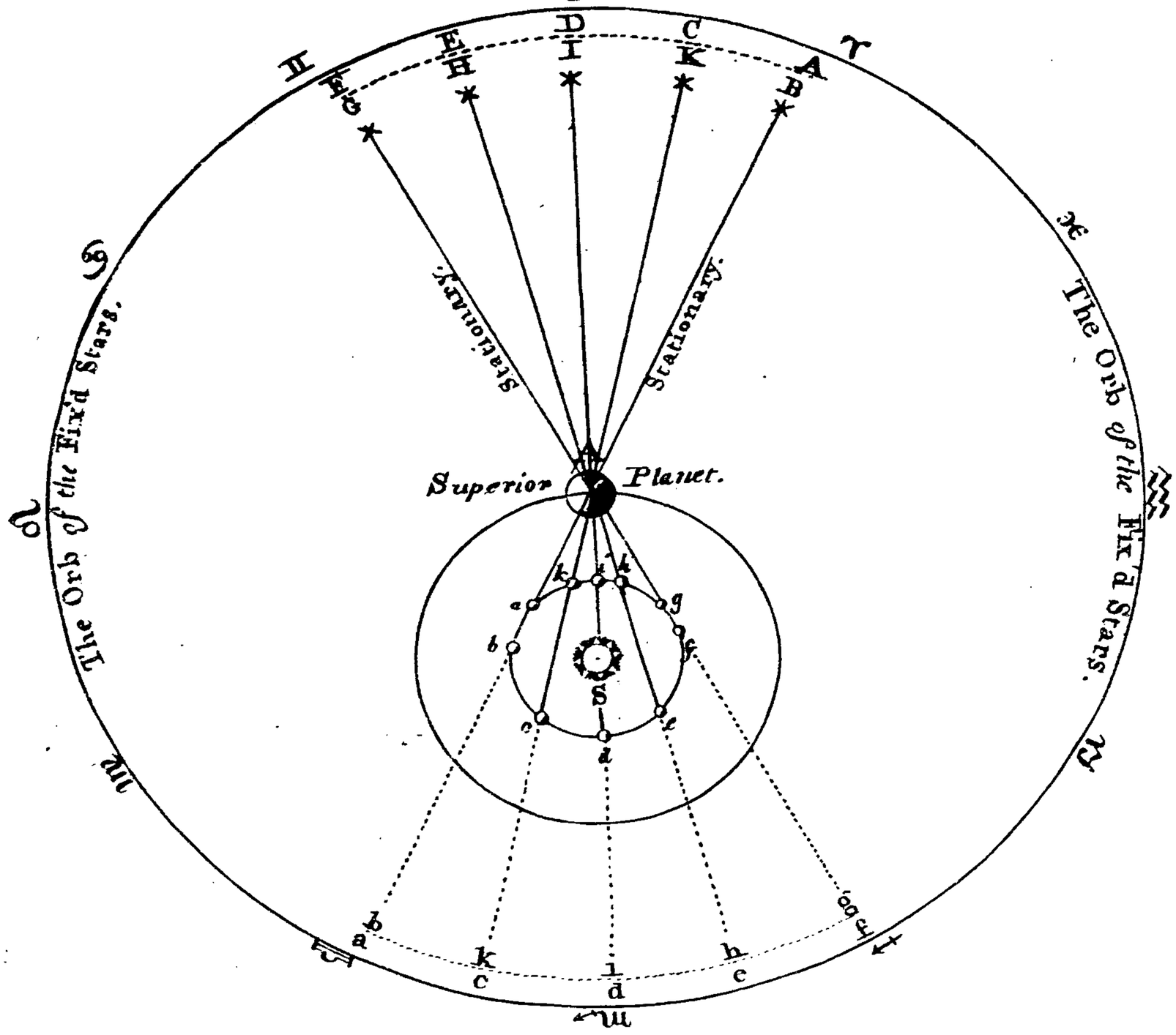
Some Comets are as *ſmall* as the Moon, and others as *large* as our Earth.

The *Diſtance* of the neareſt *fix'd Star* is about 2.200.000.000.000 Miles; and they ſeem to make one Revolution on the Poles of the Ecliptic in 25920 Years.

OF THE

STATIONS AND RETROGRADATIONS Of the PLANETS.

IF the *Planets* were viewed from the *Sun*, they would always appear to move round him *direct*, and according to the Order of the *Signs*, i. e. from *Aries* to *Taurus*, &c. but to us, who see them from the *Earth*, they appear sometimes to move on *direct*,—sometimes to be *retrograde*, or run back,—and sometimes to be *stationary*, or fixed to one particular Point in the Heavens. This *Diversity* of their *Appearances*, is owing to the united Motions of the Earth and Planets in their Orbits, as here delineated.



In this *Scheme*, let S represent the *Sun*, the Center of the *System*;—the *smaller* Circle *a*, *b*, *c*, *d*, &c. the Orbit of the *Earth*;—and the larger the Orbit of one of the *superior Planets*;—also let the outer Circle ♈, ♉, ♊, &c. represent the Orb or Sphere of the *fixd Stars*, where the Place and Motions of the Planets are determined. Then it is evident, that tho' the *Planets* all revolve round the Sun the *same Way*, and with a regular Velocity, yet to us on the *Earth* (and to one another) their Motions will seem very *different*. For sometimes they will appear to move *slowly*, sometimes to *stand still*, and at other Times to *run back*, or move contrary to their real Motions. Thus, suppose the *Earth* in her Orbit at *a*; then an Eye will behold the *superior* Planet A (suppose it be *Saturn*) in the Line continu'd from the *Earth*, *by* the *Planet*, to the *Stars* at A.—All the Time the *Earth* passes from *a* to *b*, the *Planet* will appear to *stand still*, or fix'd in the same Part of the Heavens, because the Line proceeding from the *Earth* to the Planet continues the same.—As the *Earth* moves from *b* to *c*, the *Planet* will appear to move from B to C, with a *direct* Motion among the Stars, also.—At D, he is said to be in *Conjunction* with the *Sun*, i. e. in the same Place of the Heavens with that *Luminary*; and, if in the *Plane* of the *Ecliptic*, will pass behind his *Disk*, and rise and set when he does.—As the *Earth* goes on to *e* and *f*, the *Planet* will be seen to move *direct* to E and F likewise: But whilst the *Earth* passes from *f* to *g*, the *Planet* will appear to be *stationary*, or not to move at all.—And as the *Earth* revolves to *h*, the *Planet* will seem to *run back* to H.—At *i*, he will appear at I; where he is said to be in *Opposition* to the *Sun*; he now rises as the *Sun* sets, and shines

ſhines all the Night.—As the *Earth* proceeds to *k*, the *Planet* continues to go *retrograde*; and when the *Earth* is come to *a*, the *Planet* becomes *ſtationary* as at firſt.

From this Scheme it is alſo evident that the ſame Appearances muſt happen to the *inferior Planets* as to the *ſuperior*. For an Inhabitant at the *ſuperior Planet* at A, will ſee the *inferior* move on *direct*,—become *ſtationary* and *retrograde*, at the ſame Time, and in the ſame Manner, but in the *oppoſite* Part of the Heavens.—Thus, whilſt the *ſuperior* Planet is beheld from the *inferior*, at *a* and *b*, to be *ſtationary* at AB in ♈, the *inferior* will be ſeen from thence *ſtationary* at *ab* in ♎.—When the *inferior* is at *c*, he will appear, in the oppoſite Part at *c*.—At *d*, he will appear at *d*, *conjoin'd* with, and in the ſame Part of the Heavens with the *Sun*. This Situation of an *inferior* Planet, becauſe it is ſituate beyond the *Sun*, is call'd its *ſuperior Conjunction*; and, if it has no *Latitude* at that Time, will paſs behind the *Sun*'s Body, and ſuffer an *Eclipſe*.—As he advances from *d* to *e*, he appears, from A, to move on ſtill *direct* from *d* to *e*.—At *f*, he is ſeen at *f*, where is his *greateſt Elongation* on that Side his Orbit from the *Sun*, and will ſet in the Evening after him.—Whilſt the *inferior* moves from *f* to *g*, he appears *ſtationary*, and (as it were) fix'd in the ſame Part of the Heavens, juſt as the *ſuperior* does from thence in the *oppoſite* Parts; becauſe the Lines, paſſing from each to each, terminate in the ſame Places during that Time.—But, as he proceeds from *g* to *h*, he appears to the *ſuperior* (as the *ſuperior* does to him) to go back, or *retrograde* in the Heavens.—At *i*, he will be found at *i*, *conjoin'd* with the *Sun* again. This is call'd his *inferior Conjunction*, becauſe between the *ſuperior* and the *Sun*; and, if he is exactly in the Plane of the *Ecliptic*, will paſs over the *Sun*'s Diſk, and appear like a *black Spot* on his Face.---As he revolves from *i* to *k* and *a*, he ſtill recedes *backwards*, and appears, amongſt the Stars, at *k* and *a*.---From *a* to *b* he appears *ſtationary*, as well as the *ſuperior*, and for the ſame Reaſons as they did, on the other Side of the Orbit, at *f* and *g*.---At *a* he is ſaid to be at his *greateſt Elongation* on this Side the *Sun*, and ſets before him.---At *b* he begins to move *direct* as before.

I have conſidered the *ſuperior* Planet as remaining in the ſame Part of its Orbit during one Revolution of the *Earth*, in order to convey the Ideas of their *Stations*, *Directions*, and *Retrogradations* eaſier to the Learner. For tho' they actually advance, at the ſame Time, the ſame Way, but as the Motion of the *ſuperior* is much *ſlower*, it may, in this Illuſtration, be ſafely omitted. For Inſtance, while the *Earth* revolves once round, *Saturn* will have gone but one thirtieth Part of his Orbit; *Jupiter*, in the ſame Time, would have gone about one twelfth Part; and *Mars* ſtill further.---Whence it follows, that theſe *Appearances* happen oftener in *Saturn* than in *Jupiter*; and oftener in *Jupiter* than in *Mars*; becauſe the *Earth* ſooner overtakes (or comes up with) the former Planets than the latter, whoſe Motion is faſter. And, for the ſame Reaſon, they happen oftener in *Mercury* than in *Venus*, becauſe he circulates not only faſter, but in a leſs Orbit, and therefore oftener overtakes the *Earth*. Theſe *Retrogradations* are greater, the nearer the Planets are to the *Earth*.

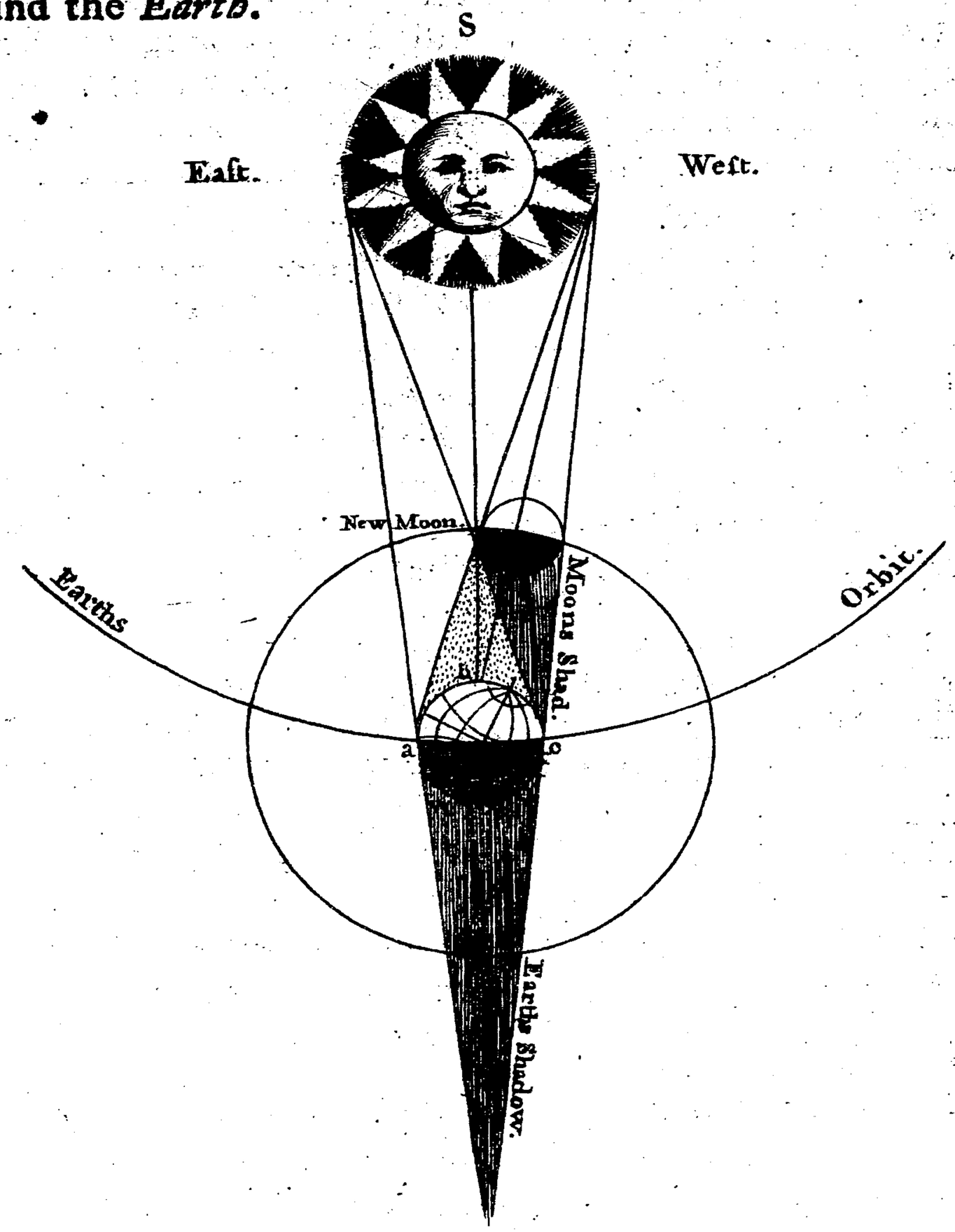
☞ If two Planets are on the *ſame Side* the Sun, they appear *retrograde* to each other;--if, on the *contrary Side*, they always appear *direct*;--but for ſome *little Time* before and after their *Conjunctions*, they appear *ſtationary*. This is an undeniable Proof of the *Earth*'s Motion, and that the preſent *Syſtem* is the *true Syſtem of the World*: Becauſe, if the *Earth* be ſuppos'd to remain fix'd in the Center of the Univerſe, theſe various Motions could never take Place here; but all the Planets would appear to move (as they really do) *the ſame Way*, and revolve (like the *Moon*) regularly round us.

Of ECLIPSES.

AN *Eclipſe* is that *Obſcuration*, or *Deprivation* of *Light*, in any of the heavenly Bodies, caus'd by ſome other coming between the *Sun* and that Body. There are various Kinds of *Eclipſes* in the Heavens, but thoſe of the SUN and MOON are moſt remarkable.

ECLIPSE of the SUN.

THE *Eclipſe* of the *Sun* (or more truly of the *Earth*) is caus'd by the *Moon*, as ſhe revolves in her Orbit, coming between the *Sun* and *Earth*, and by that means hiding his Light from us. This can never happen but at the *New-moon*, as is evident from an Inſpection of the following Scheme; in which S repreſents the *Sun*, E the *Earth*, and M the *Moon* in her Orbit revolving round the *Earth*.



Now, when the *Moon* is come in Conjunction with the *Sun*, i. e. juſt between *Us* and *Him*, which can never happen but at the *New-moon*, it is manifeſt that her Shadow will fall upon the *Earth* at *a*, and thereby hide his Face and Light from thoſe who live upon that Spot. But as the *Moon* is much leſs than the *Earth*, the Shadow of the *Moon* cannot cover the whole but only Part of the Surface next it. For this Reaſon, you ſee that the ſame *Eclipſe* of the *Sun* may be total to one Country;—to another *partial*, or Part eclips'd:—and to a third, none at all.

Thus

Thus, in the above Scheme, it is manifeſt that to the Inhabitants of that Part of the *Earth* marked *a*, the *Sun* will ſeem to be *totally* dark, they being wholly involv'd in the Shadow.——To thoſe at *b*, he will appear to be eclips'd in *one Part only*, and the more ſo the nearer the Spectator is to *a*, they being immers'd only in the *partial Shadow*.——And to thoſe that live at *c*, he will not be *eclips'd at all* *.——At the ſame Time, an Eye at the upper Part of the *Moon*, will ſee the *Sun* free from any Obſcurity, whilſt thoſe on the under Side will behold the *Earth*, Part of it, involv'd in a *duſky Shade*.

The *Sun's Eclipſe* always begins on the *Weſt*, and ends on the *Eaſt* Side his Body. The Reaſon is, becauſe the *Moon*, which is always the Cauſe of this Obſcurity, moving round her Orbit from Weſt to Eaſt, muſt neceſſarily firſt arrive at, and touch the *Sun*'s Weſtern Limb, and go off at the Eaſtern.

As the *apparent* Diameters of the *Sun* and *Moon* are nearly equal, the total Duration of an *Eclipſe* of the *Sun* can never continue more than *two Minutes*; but the ſame *ſolar Eclipſe*, from *Beginning* to *End*, may be $2\frac{1}{4}$ *Hours*.

In order to determine the Quantity of an *Eclipſe*, *Aſtronomers* have divided the *Sun's Diameter* in 12 equal Parts, call'd *Digits*; and therefore, when they ſay the *Sun* will be eclips'd 5 or 6 *Digits*, they only mean, 5 or 6 Fingers Breadths of the *Sun* will be obſcur'd or darken'd, whilſt the reſt will continue bright and viſible to the Spectator.

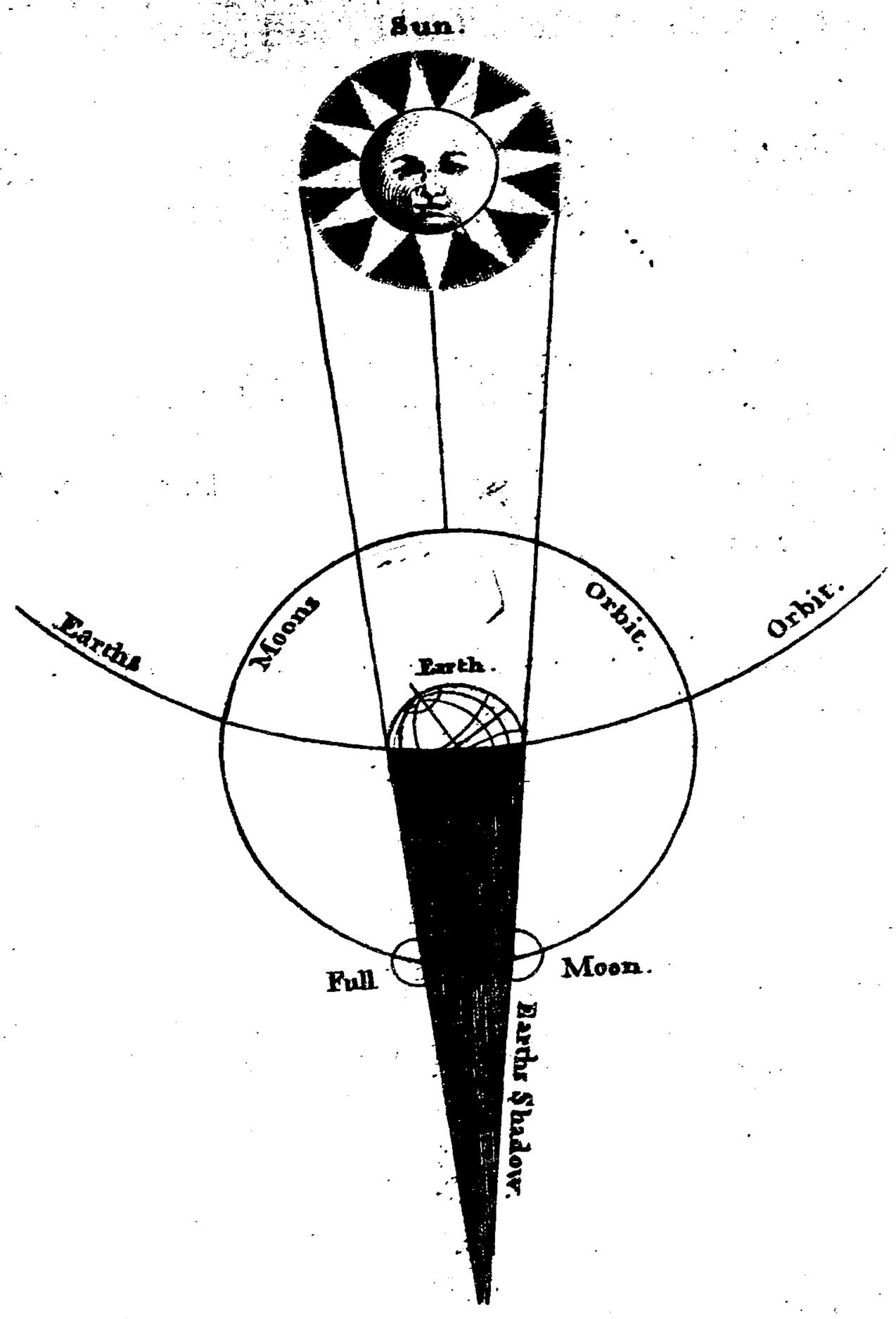
An *Eclipſe* of the *Sun* can only be viſible by *Day*, when the *Sun* is above the *Horizon:* And though there be 12 *New-moons* every Year, yet it is ſeldom we have more than 4 *Eclipſes* of the *Sun*, the Reaſon of which will be ſhewn 2 or 3 Pages further on.

* The Shadow of the Moon will cover a greater or leſs Portion of the Earth's Surface, as the Moon happens to be nearer or further from us at the Time of the Eclipſe. At a mean, the ſhadow may ſpread itſelf over 180 Miles in Diameter, and move at the Rate of 2104 Miles in an Hour. But the *partial* or *penumbral* Shadow will extend the Breadth of 4900 Miles; and be five Hours in paſſing over the Earth's Diſk.

☞ In the early Ages of the World, the Nature and Cauſe of *Eclipſes* was ſo little known, that the Ignorance and Superſtition of thoſe Times looked on them as Prodigies, and portentous of ſome great and malevolent Effects: But the Learning of the preſent Age has taught us, that theſe Appearances happen according to the Courſe of Nature, and are the neceſſary Reſult of thoſe Laws which the Divine Being gave them at the Creation.——*Ricciolus*, in his *Almageſt*, relates a Story of *Columbus*, who being drove on Shore at the Iſland of *Jamaica*, in 1493, and meeting with great Diſtreſs and Cruelty from the barbarous Inhabitants, threaten'd to afflict them with ſome grievous Calamity; aſſuring them, as a Mark of his Power, that on ſuch a Day the *Sun* ſhould be darken'd; which, by an *Eclipſe*, happen'd on the Day he had aſſigned. This ſurpriſing Phænomenon wrought ſuch Terror in their Minds, that they look'd on him as ſomething more than human; and, therefore, they afterwards did all in their Power to ſerve him.

ECLIPSE of the MOON.

AN *Eclipſe* of the *Moon* is caus'd by the Interpoſition of the *Earth* between the *Sun* and *Moon*: This can only happen at the *Full-moon*, when ſhe is directly oppoſite the *Sun*; for the *Earth*, being then exactly between the *Sun* and the *Moon*, will caſt her Shadow upon the *Moon*, juſt as the *Moon* did her Shadow upon the *Earth* before, in the *Eclipſe* of the *Sun*. This is clear from a Sight of the following Figure; where it is evident, that when the *Moon* is arriv'd to the oppoſite Part of her Orbit, ſhe falling, more or leſs, into the *Earth's Shadow*, is by that Means depriv'd of her Light from the *Sun*, and ſo ſuffers an *Eclipſe*.



If *only* Part of the *Moon*'s Body paſſes through the *Earth's Shadow*, ſhe is ſaid to ſuffer a *partial Eclipſe*.——If the *whole Body* is immers'd in the *Shadow*, and begins immediately to emerge again, the *Eclipſe* is ſaid to be *total without Continuance*.——But if the *Moon* paſſes through the *Middle* of the *Shadow*, (or near it) her Stay there will be conſiderable; as the *Shadow*, in that Part of it, is about three Times broader than the *Moon*, and the *Eclipſe* will be *total with Continuance*.

An

An *Eclipſe* of the *Moon* appears to all Parts where it is viſible to be the ſame in *Quantity* and *Duration* as it really is. For the *Moon* being an *opaque* Body, ſhining only with a reflected Light from the *Sun*, is depriv'd of that Light by being immers'd in the *Earth's Shadow* *.

The *Moon's Eclipſe* begins always on the *Eaſt* Side, and ends on the *Weſt*, contrary to that of the *Sun*. For her *Eclipſe* being *real*, and by Reaſon of her direct Motion always *Eaſtward*, the *Eaſtern* Part of her Body muſt neceſſarily firſt touch the *Earth's Shadow*, and the *Weſtern* Part leave it laſt.

The *Shadow* of the *Earth*, where the *Moon* paſſes through it, being almoſt *three* Times as large as the *Diameter* of the *Moon*, it will often happen, that *total Eclipſes* of the *Moon* may be of very different Lengths; but it is ſeldom that *total Darkneſs* continues more than 1¾ Hour, or the *whole Eclipſe*, from *Beginning* to *End*, more than 3¼ Hours.

The Body or Diſk of the *Moon* is ſuppos'd to be divided (like that of the Sun) into twelve equal Parts, or *Digits*; and as many as are the Parts immers'd in the *Earth's Shadow*, ſo many *Digits* is the *Moon* ſaid to be eclips'd. But as the Diameter of the *Shadow* is far greater than the Diameter of the *Moon*, it muſt follow, that, when the *Moon* is immers'd in the Middle of the *Shadow*, not only the twelve *Digits* are eclips'd, but there remains a conſiderable Part of the *Shadow* to be paſs'd thro' ſtill. In *Lunar Eclipſes*, therefore, which are total, we reckon the Number of *Digits* according to the Quantity of the *Earth's Shadow* over, or beyond the *Moon*, when it is immers'd wholly in the *Shadow*, which may ſometimes extend to 23 *Digits* nearly.—All above 12 ſhew how many Parts of the *Shadow* the *Moon* has to paſs thro' before ſhe begins to appear on the oppoſite Side.

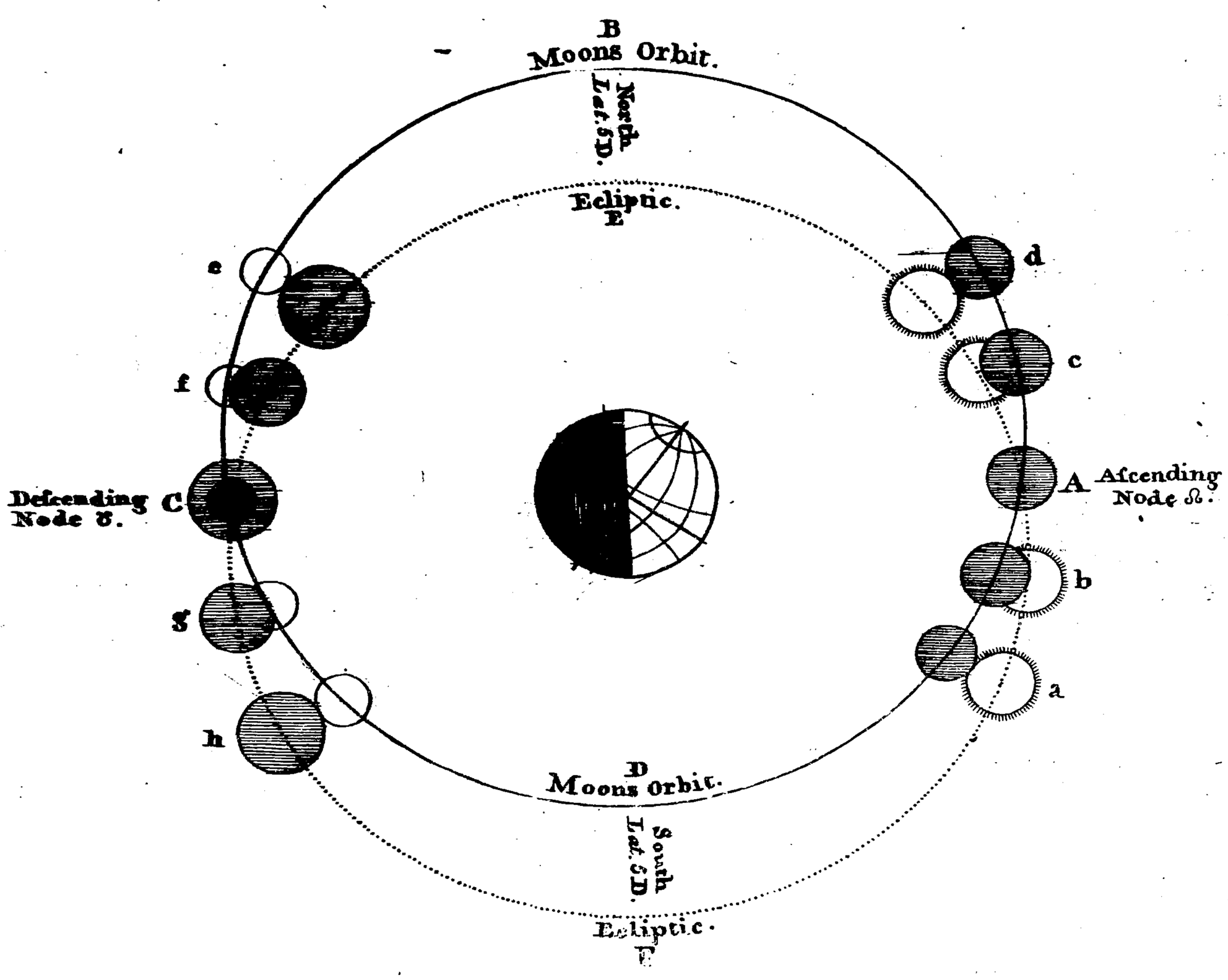
The *Moon's Eclipſe* is viſible only by *Night*, i. e. when ſhe is *above* the *Horizon*: And though we have twelve *Full-Moons* within the Circle of the Year, yet never more than *three of them* ſuffer an *Eclipſe*. The Reaſon you will find in the next Pages.

* In *total Eclipſes* of the *Moon*, when ſhe is in or near the Center of the Earth's Shadow, her Body is frequently ſeen of a *languid ſwarthy Colour*: This is owing not to any Light ſhe has in herſelf, but to the *Rays* of the *Sun* falling into our *Atmoſphere*, which being thereby refracted, are bent out of their direct Courſe into the Shadow: Theſe Rays falling upon the *Moon*, when ſhe is even in the Middle of the Shadow, render her viſible to the Spectators at that Time.

☞ From the Writings of the Apoſtles we learn, That at our *Saviour's Crucifixion* there was *Darkneſs over all the Land from the ſixth to the ninth Hour*, i. e. from 12 to 3 in the Afternoon; which Darkneſs ſome Perſons may, perhaps, attribute to an *Eclipſe* of the *Sun*. But that is impoſſible: For *Chriſt* ſuffer'd at the Time of the *Jewiſh Paſſover*, which was always celebrated at the *Full-moon*, when theſe two Luminaries are in Oppoſition to, and at their greateſt Diſtance from each other. Beſides, ſuch uncommon Darkneſs could not happen from any *natural Eclipſe* of the *Sun*: For, as the *apparent* Diameters of thoſe two Planets are nearly equal, ſuch Eclipſe could not laſt but a *few Minutes*, whereas *this* Darkneſs laſted about *three Hours*.—*Dionyſius*, a Judge of *Areopagus*, near *Athens*, being at *Heliopolis*, and obſerving this *præternatural Phænomenon*, cry'd out, that *Nature was diſſolving, or the God of Nature ſuffers*. He afterwards embrac'd the Chriſtian Faith (from this Aſtronomical Conviction), and ſuffer'd Martyrdom for the Truth of it.

Of the LIMITS of ECLIPSES both SOLAR and LUNAR, with the *yearly Number* of each, and the *Times* when they happen.

THE Reaſon why the *Sun* is not eclips'd at every *New-moon*, nor the *Moon* at every *Full*, is becauſe the *Moon's Orbit* does not lie in the ſame Plane or Tract with that of the *Earth*'s, which is call'd the *Ecliptic Line*, but cuts or croſſes it in two oppoſite Points, making an Angle therewith of about 5 Degrees. Theſe two Points or Interſections are call'd the *Nodes* of the *Moon*. The Point where the *Moon* begins to aſcend above, or become Northward of the *Ecliptic Line*, is call'd the *aſcending Node*, and is uſually mark'd by *Aſtronomers* thus (☊). The other Point, from which the *Moon* begins to deſcend below, or go Southward of the *Ecliptic*, is call'd the *deſcending Node*, and is mark'd thus (☋). See the following Scheme.



In this Scheme, let the larger black Circle, ABCD, repreſent the *Moon's Orbit* with the *Earth* in the Center: And let the dotted one, AECF, repreſent the *Ecliptic*, or Plane (at the Diſtance of the *Moon*) in which the *Sun* and *Earth's Shadow* appear to move. Then will A and C be the two *Nodes*, or Knots where the *Moons' Orbit* and *Ecliptic* interſect each other in an Angle (at A and C) of 5 Degrees; one *half* of the *Moon's Orbit*, ABC, being above the *Ecliptic*, the other *half*, CDA, below it. The little Suns upon the dotted Circle, about the *Node* A, repreſent the *Sun* in thoſe Parts of the *Ecliptic*; and the little ſhaded Circles are the *New-moons*, at thoſe Places alſo.——On the *oppoſite Side*, the black

black Circles repreſent *Sections* of the *Earth's Shadow*, which are always oppoſite the *Sun*; and the lighter Circles are the *Moons*, which happen there at the *Full*.

Now, ſuppoſe the *Moon*, in paſſing round her *Orbit* (which ſhe does every Month), comes into *Conjunction* with the *Sun* at *a*, where ſhe is below, or Southward of the *Ecliptic Line*, then it is apparent (from the Figure) that her *upper* Limb will juſt touch the *Sun's lower* Limb, without eclipſing it.—But if the *New-moon* happens at *b*, then the *Moon* will paſs over the lower Part of the *Sun's Diſk*, and cauſe an *Eclipſe*.—If at the Time of the *New-moon*, the *Moon* meets with the *Sun* in the very *Node*, at A; then there will happen a *central* and *total Eclipſe* of the *Sun*. But as their apparent *Diſks* are nearly equal, the *total Darkneſs* will continue but two or three Minutes at moſt.—If the *New-moon* happens at *c*, then you ſee there will be a *partial Eclipſe* of the *Sun*; and the *Sun's upper* Part will be obſcur'd, as the *Moon* is now got Northward, or above the *Ecliptic Line*.———If the *Luminaries* meet at *d*, then the *Moon's lower* Limb will touch the *Sun's upper* Limb, but paſs by without eclipſing him.

Again; As the *Moon* paſſes from the *Sun* to the oppoſite Part of her *Orbit*, where ſhe is in the *Full*, as at *e*, then her *lower* Limb will juſt touch the *Edge* of the *Earth's Shadow*, but paſs over it without being, in any Part, eclips'd.—But if the *Full-moon* happens nearer the *Node*, at *f*, then the *lower* Part of the *Moon* dips into the *Shadow*, and cauſes a *partial Eclipſe*.——But if the *Full-moon* falls at the very *Node* C, the *Moon* paſſing there thro' the *Middle* of the *Shadow* will be *totally* and *centrally eclips'd*; which *Eclipſe* will be of ſome Continuance, as the *Shadow* is, in that Part, nearly three Times the Diameter of the *Moon's Body*.——— If the *Oppoſition*, or *Full-moon* happens at *g*, then there will be a *partial Eclipſe*; but the *upper* Part of the *Moon* will be immers'd in the *lower* Part of the *Shadow*, becauſe ſhe is now deſcended below the *Ecliptic*.——At *h*, the *Moon's* full *Diſk* paſſes under the *Shadow* free from any Obſcuration.

The *Diſtance* of the *Moon*, in *Degrees* and *Minutes*, above or below the *Ecliptic Line*, is call'd her *Latitude*. If ſhe is above the *Ecliptic*, ſhe is ſaid to have *North Latitude*; if below it ſhe has *South Latitude*: And if the *Latitude*, at any Time, exceed the Sum of the *Semidiameter* of the *Moon* = $16\frac{1}{4}$ Minutes, and the *Earth's Shadow* = $45\frac{3}{4}$ Minutes, the *Moon*, at that Time, cannot be eclips'd; but will either paſs under or over the *Shadow*, juſt as ſhe happpens to be above or below the *Ecliptic Line*.—The Diſtance from the *Node*, either before or after it, correſponding to the above *Latitude*, is about 12 Degrees; conſequently, that is the Limit of *Lunar Eclipſes*. For, when a *Full-moon* happens within 12 Degrees of the *Node*, then ſhe will be eclips'd; and the nearer the *Node*, the *greater* will the *Eclipſe* be.

If at the *New-moon*, the *Latitude* of the *Moon* exceeds the Sum of the *Semidiameters* of the *Sun*, = $16\frac{1}{4}$ Minutes, and the *Moon*, = $16\frac{3}{4}$ Minutes, we ſhould ſee no *Eclipſe* of the *Sun*, if beheld from the *Center* of the *Earth*: But

But as we view the Luminaries from the *Surface*, which is much higher, we are obliged to take in the *Semidiameter* of the *Earth* likewiſe, = 61½ Minutes. Then, I ſay, if the Latitude of the *Moon* be greater than the Sum of theſe three Numbers. = 94¼ Minutes, the *Sun* will not be eclips'd; for the *Moon* will paſs either over or under his *Diſk*, according as ſhe is above or below the *Ecliptic Line*. —— The Diſtance from the *Node*, on either Side it, agreeing to this *Latitude* of the *Moon*, is about 18 Degrees, which is the utmoſt Limit of *ſolar Eclipſes*: Whence it follows, that if the *Sun* and *Moon*, at the Time of *New-moon*, happen to be within 18 Degrees of the *Node*, the *Sun* will ſuffer an *Eclipſe* at that Time, and the *greater* the *nearer* they are to the *Node*.

If the *Sun* ſhould happen to be eclips'd on one Side the *Node*, juſt within the *Limit* between *a* and *b*; then the following *Full-moon* will be eclips'd, but not in the oppoſite Degree of the *Ecliptic*, but ſomething nearer the *Node* C; becauſe the *Earth's Shadow* is advanc'd about 14 Degrees forwarder in the *Ecliptic* in that Time. And the returning *New-moon* will overtake the *Sun*, and eclipſe him again, ſomewhere between *c* and *d*.—But if an *Eclipſe* of the *Sun* happen at, or near the *Node* A, then the following *Full-moon* will not arrive at the *Earth's Shadow* (which is ſtill moving forward) till it is beyond the ecliptic Boundary at *b*; ſo that there can be no *Eclipſe* at that *Full*.—The other *New* and *Full-moons* will paſs without being productive of any *Eclipſe*, till the *Sun* arrives to the oppoſite *Node* C; where the ſame *Number* and *Kind* of *Eclipſes*, which fell at the former *Node*, will fall again at this. For the *Sun* and *Earth's Shadow* having only chang'd Places, the ſame *Eclipſes* muſt be repeated, in the ſame Manner, and for the ſame Reaſons, as before. Hence it is manifeſt, that there can never happen more than *ſix Eclipſes* in any Year, *i. e. two* of the *Sun* and *one* of the *Moon* at each *Node*; nor leſs than *two*, i. e. *one* of the *Sun* at each *Node*, without any *Lunar one*.

As *Eclipſes* only happen in thoſe Months in which the *Sun* enters the *Signs* where the *Moon's Nodes* are ſituate; and as the *Nodes* are directly *oppoſite*, the *Times of Eclipſes* will happen at *oppoſite* Parts of the *Year*. Thus, if any *Eclipſe* happens in *January* or *February*, then will alſo happen *another* in *June* or *July*; the *Sun*, in thoſe *Months*, being in Signs of the *Ecliptic oppoſite* to one another.

Of the PERIOD of ECLIPSES, Both SOLAR and LUNAR.

IF the Places of the *Nodes* were fix'd, *Eclipſes* would always happen nearly at the ſame Seaſons of the Year: But as they have a Motion of about 3 Minutes 11 Seconds every Day backwards in the *Ecliptic*, or contrary to the Order of the *Signs*, i.e. from *Aries* to *Piſces*, &c. the ſucceeding *Eclipſes* muſt recede backwards, from *March* to *February*, likewiſe: And in one Revolution of the *Nodes*, which is in 18 Years, 224 Days, 3 Hours, they will revolve in a *retrograde* Manner thro' the Year, and return to the ſame Places again.

But there is a more correct *Period* of *Eclipſes* diſcover'd by Obſervation; which is 18 Years, 11 Days, 7 Hours, and 43 Minutes: For, in that Time, the *Sun* and *Moon* advance juſt as far beyond a compleat *direct Revolution* in the *Ecliptic*, as the *Nodes* want of compleating their *retrograde* one. Conſequently, as the *Sun* and *Moon* meet the *Nodes* at the End of that Period, the ſame *ſolar* and *lunar Aſpects*, which happen'd 18 Years, 11 Days, 7 Hours, and 43 Minutes ago, will *return*, and produce *Eclipſes* of both *Luminaries*, in *Number* and *Quantity* the ſame as before.—On this *Principle* the following *Table* and *Calculations* are conſtructed.

☞ The ſame Kind of Eclipſes happen to *Jupiter* and *Saturn*: But as *Jupiter* has four Moons, and *Saturn* five, and as their Revolutions are much quicker than ours, Eclipſes muſt happen more frequently there than here.

The USE that may be made of ECLIPSES is very great, not only to the *Aſtronomer* and *Chronologiſt* in aſcertaining more accurately the Periods of the Planets, and fixing the antient Accounts of Time, but to the *Geographer* and *Mariner* in determining the LONGITUDE of Places at *Sea* or *Land*. For having an *Eclipſe* truly calculated to any particular *Meridian*, as ſuppoſe *London*, where the *Eclipſe* is found by Calculation to begin at $5^h\ 32^m$, in the Afternoon; and being at *Sea*, the ſame *Eclipſe* is obſerv'd to begin at $6^h\ 16^m$, the Difference, which is 44^m, turn'd into Time, allowing for every 4 Minutes 1 Degree, makes 11 Degrees, and ſo much is the Obſerver to the *Eaſtward* of *London*.——— But if the Time had been found to be *ſooner* than by the Calculation, then is the Perſon ſo much to the *Weſtward* of *London*. By this Diſcovery the *Mariner* is enabled to paſs with greater Safety thro' the Surface of the *path'leſs Deep*, for by knowing where he is, he knows the better how to evade the Dangers, and to direct his Courſe to the *wiſh'd for Port*.

A TABLE OF ECLIPSES,

So adapted, that the *young Aſtronomer* may, with very little Trouble, calculate the *Number* of *Eclipſes* in any *Year*; diſcover whether they are of the *Sun* or *Moon*; with the Quantity eclips'd; and the exact Time of the *Day* or *Night* they fall on.

	Mon.	D	H	M	Lat. ☽		Lum.
Leap 1744	Apr.	1	9	51	0 39	SD	Sun
	Apr.	15	8	32	0 35	SA	Moon
	Sept.	24	13	18	0 44	ND	Sun
	Oct.	10	0	48	0 40	NA	Moon
1745	Mar.	21	14	56	0 2	NA	Sun
	Sept.	14	5	20	0 1	ND	Sun
1746	Feb.	24	3	44	0 37	ND	Moon
	Mar.	10	14	54	0 42	NA	Sun
	Aug.	19	12	5	0 39	SD	Moon
	Sept.	3	21	22	0 43	SA	Sun
1747	Jan.	29	2	52	1 21	SD	Sun
	Feb.	13	17	2	0 5	SA	Moon
	Feb.	27	17	18	1 21	NA	Sun
	July	25	20	50	1 9	ND	Sun
	Aug.	8	20	52	0 4	NA	Moon
	Aug.	24	9	28	1 26	SA	Sun
Leap 1748	Jan.	18	15	25	0 40	SD	Sun
	Feb.	2	23	49	0 46	SA	Moon
	July	13	22	50	0 4	ND	Sun
	July	28	11	34	0 49	NA	Moon
1749	Jan.	7	7	17	0 2	NA	Sun
	June	18	21	34	0 59	ND	Moon
	July	3	0	31	0 15	SA	Sun
	Dec.	12	8	8	0 44	ND	Moon
	Dec.	27	21	12	0 13	SD	Sun
1750	June	8	9	9	0 15	SD	Moon
	June	22	6	51	0 58	SA	Sun
	Nov.	17	13	19	1 22	SD	Sun
	Dec.	1	18	32	0 3	ND	Moon
	Dec.	17	6	34	1 23	NA	Sun
1751	May	13	12	51	0 51	ND	Sun
	May	28	13	58	0 28	NA	Moon
	Nov.	6	12	43	0 44	SD	Sun
	Nov.	21	9	47	0 39	SA	Moon
Leap 1752	May	2	5	45	0 6	ND	Sun
	Oct.	25	13	59	0 5	SD	Sun
1753	Apr.	6	6	20	0 45	SD	Moon
	Apr.	21	19	37	0 39	SA	Sun
	Sept.	30	21	36	0 41	ND	Moon
	Oct.	14	21	59	0 11	NA	Sun
1754	Mar.	12	10	12	1 20	ND	Sun
	Mar.	26	19	47	0 2	SD	Moon
	Apr.	11	2	45	1 19	SA	Sun
	Sept.	5	4	43	1 21	SD	Sun
	Sept.	19	22	28	0 1	ND	Moon
	Oct.	4	13	31	1 17	NA	Sun
1755	Mar.	1	9	45	0 40	ND	Sun
	Mar.	16	12	12	0 42	NA	Moon
	Aug.	25	20	30	0 37	SD	Sun
	Sept.	8	22	40	0 34	SA	Moon
Leap 1756	Feb.	18	13	48	0 8	ND	Sun
	Aug.	14	7	12	0 7	NA	Sun
1757	Jan.	23	19	6	0 38	SD	Moon
	Feb.	7	1	2	0 41	SA	Sun
	July	19	11	53	0 30	ND	Moon
	Aug.	3	10	45	0 49	NA	Sun
	Dec.	29	6	11	1 20	ND	Sun
1758	Jan.	12	18	13	0 0	NA	Moon
	Jan.	27	16	37	1 23	SA	Sun
	June	23	20	55	1 5	SD	Sun
	July	9	4	44	0 15	SA	Moon
	Dec.	18	19	29	0 40	ND	Sun
1759	Jan.	1	19	46	0 39	NA	Moon
	June	13	5	23	0 1	SD	Sun
	Dec.	8	2	14	0 1⅛	SA	Sun
Leap 1760	May	18	9	35	0 52	ND	Moon
	June	1	19	24	0 20	SD	Sun
	Nov.	11	9	18	0 44	SD	Moon
	Nov.	26	2	2	0 38	SA	Sun
1761	Apr.	23	5	40	1 24	SD	Sun
	May	7	10	2	0 11	ND	Moon
	May	22	13	24	1 9	NA	Sun
	Oct.	16	10	29	1 27	ND	Sun
	Oct.	31	23	43	0 2	SD	Moon
	Nov.	15	2	15	1 16	SA	Sun

In this Table, the 1ſt Column expreſſes the Year—the 2d, the Day, Hour, and Minute—the 3d, the Moon's Latitude at the Middle of the Eclipſe—and the 4th, the Luminary eclips'd.

☞ *The Moon's Latitude is nearly the ſame on the Return of the ſame Eclipſe, ſeldom differing more than a Minute or two.*

The

The USE of the foregoing TABLE.

ADD 18 Years, 10 or 11 Days, 7 Hours, and 43 Minutes to any *Eclipſe* in the Table, and the Sum will be the *Return* of the *ſame* Eclipſe.—If there be but 4 *Leap Years* in the 18 add 11 Days; if 5 *Leap Years* add only 10 Days.

In theſe *Calculations*, the Day is always ſuppos'd to begin at *Noon*, and end after 24 Hours, on the next day at *Noon*.—When the Day is in *December*, and the Addition of 10 or 11 Days makes it more than 31, then the *Overplus* muſt be reckon'd as ſo many Days in *January* in the following Year.—The ſame muſt be done with Reſpect to the Months.

☞ Remember to add 11 Days more, for the Alteration of the *Style*, after *September* 14th, 1752.

An Example or two will make all plain,—By this *Table* it appears that the *Sun* was eclips'd

			D.	H.	M.	
	1745	Sept.	14	5	20	*Old Style.*
Add, becauſe there are 4 *Leap Years* in the	18		11	7	43	
Gives *firſt Return* of that *Eclipſe*	1763	Sept.	25	13	3	
Add 11 Days for Alteration of the *Style*			11			
		Sept.	36	13	3	
Deduct for the Month *September*			30			
Gives	1763	Oct.	6	13	3	*New Style.*
Add, becauſe there are 5 *Leap Years* in the next	18		10	7	43	
The *next Return* of the ſame *Eclipſe*	1781	Oct.	16	20	46	*New Style.*

Hence it is evident, that the *Sun* will be eclips'd *October* 16^{d} 20^{h} 46^{m}; that is, the 17th Day at 3 Quarters paſt 8 o'Clock in the Morning.

From the ſame *Table* you may calculate *backwards*, or for Years paſt.--For, by only *ſubtracting* 18 Years, 10 or 11 Days, 7 Hours, and 43 Minutes from any *Eclipſe* in it, you will have the Time when that *Eclipſe* happen'd before.

Thus the *Sun* was eclips'd as above	1745	Sept.	14	5	20	*Old Style.*
Subtract, becauſe there were 5 *Leap Years* in the	18		10	7	43	
Happen'd before in	1727	Sept.	3	21	37	
Subtract, becauſe only 4 *Leap Years* in the	18		11	7	43	
Happen'd before	1709	Aug.	23	13	54	
Subtract, becauſe 5 *Leap Years* in the	18		10	7	43	
Happen'd before	1691	Aug.	13	6	11	*Old Style.*

All theſe were great *Eclipſes* of the *Sun*, ſomewhere upon the Earth, as the *Moon* was (you ſee in the Table) very near the *Southern Node* *.

* If the *Moon's Latitude* be leſs than 58 Min. the Eclipſe will be *total* to ſome Part of the Earth: If more than 58, and leſs than 90, the Eclipſe will be *partial* only: If more than 90 or 92, the Sun will not be eclips'd at all ——To find its *Beginning* and *End*. From 8100 ſubtract the Square of the *Moon's Latitude*; the *Square Root* of that *Remainder*, divided by 31, will give *Half the Continuance* of the Eclipſe, in *Hours* and *Minutes*; which added to, and ſubtracted from the *Middle*, found by this Table, will give you the Time it *begins* and *ends*, i. e. when the Shadow firſt touches the Earth, and when it laſt leaves it. This Calculation does not determine the *Beginning* and *End* to any particular Place, as *London*, &c. That requires another Method, and is difficult on Account of the *Moon's Parallax*.—The *Shadow* of the *Moon* travels, in ſolar Eclipſes, over the Earth, at the Rate of about 36 Miles in a Minute.

In

In like Manner you may calculate an *Eclipſe* of the *Moon*.

		D.	H.	M.	
By this Table you ſee the *Moon* was eclips'd	1744 Apr.	15	8	32	*Old Style.*
Add, becauſe there are only 4 *Leap Years* in the	18		11	7	43
Return of that *Eclipſe*	1762 Apr.	26	16	15	
Add 11 Days for the Alteration of the *Style*			11		
	1762 May	7	16	15	*New Style.*

Hence we find that the *Moon* was eclips'd on *May* 8, about a Quarter paſt 4 o'Clock in the Morning; and that her upper Limb was immers'd in the lower Part of the *Earth*'s Shadow, becauſe ſhe had about 35 Minutes of *South Latitude*.——If the *Latitude* of the *Moon* be leſs than 26 Minutes the Eclipſe will be *total*: If more than 26, and leſs than 58 or 60, the Eclipſe will be *partial* only: But if more than 60, there will happen *no Eclipſe* at all.

To find the *Quantity*, or *Digits eclips'd*. —— From 58 ſubtract the *Moon's Latitude*, multiply the Remainder by 6, and divide the Product by 16, ſo will the Quotient give the Digits ſought.

To find (nearly) the *Beginning* and *End*.——From 3364 ſubtract the *Square* of the *Moon's Latitude*, the *Square Root* of that Remainder, divided by 31, will give the *Hours* and *Minutes* of *Half the Continuance*, which *ſubtracted from*, and *added to* the *Middle*, (found as above) you will have the *Beginning* and *End* of that Eclipſe *.

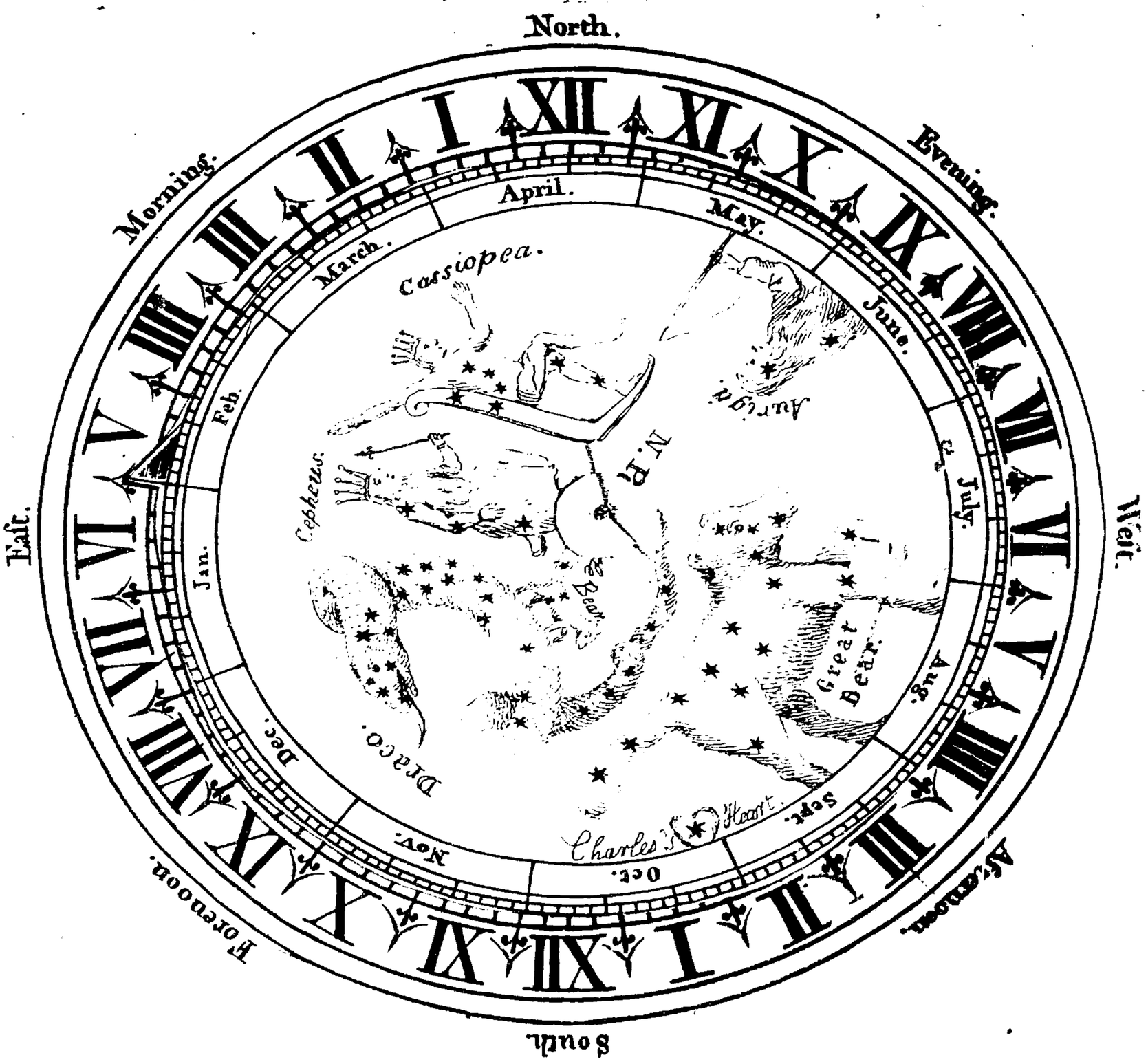
☞ Theſe are the *Laws* which *GOD*, the great Former of the *Univerſe*, gave to the Heavenly Bodies at the Creation, which *Laws* are *conſtant*, *uniform*, and *regular* without Variation. To arrive to a perfect Knowledge of them is to arrive to the *Apex*, or Top of all *human Learning*.——What lofty—what exalted Ideas muſt we have of the *Deity!* his *Wiſdom*, *Power*, and *Goodneſs!* when we view the *ſtupendous Canopy* of Heaven, and raiſe our Heads in Contemplation to that almoſt *infinite Extenſion* of the ſtarry Firmament!---And when we are there, if we have liv'd *good* and *pious* Lives on this our *probationary* Planet below, our *Souls* want but a Step or two to penetrate into the *Abodes* of the *Bleſſed*, and be *happy for ever*.

* The *Reaſon* of this Rule may be ſeen at Page 36 of my *Trigonometry*.

THE

THE DESCRIPTION AND USE OF THE ASTRONOMICAL CLOCK.

THIS Inſtrument conſiſts of two Parts, the one *fix'd*, the other *moveable*. The *fix'd* Part is a Circle divided into the 24 Hours of the Day. The upper XII ſtands for 12 at *Noon*, and the lower XII for 12 at *Midnight*.—The other Part is a *moveable* Circle, with ſuch *Stars* and *Conſtellations* delineated in it as are near the North Pole, and never ſet in this part of the World. The Stars are bounded with the 12 Months, the Days of which are ſo adapted, as to ſtand againſt the Star, which comes to the South, or upper Part of the *Meridian*, with the *Sun*, at 12 o'Clock on thoſe Days.



The *Uſe* of this Inſtrument is pleaſant and eaſy. For, only hold up the Book, turning the Back of it towards the *North Pole*; then move the inner Circle about, till the Stars inſerted therein lie in the ſame Situation with thoſe you ſee in the Heavens; (as the *Great Bear*, commonly call'd *Charles's Wain*, the *Little Bear*, &c.) and againſt the Day of the Month you have the Hour of the Night.——Or, you may find the Hour of the Night by only ſtepping out, and obſerving what Star is on or near the *Meridian*, either above or below the Pole: Then ſet the ſame Star on the inner Circle to the ſame Poſition, and the Day of the Month will point the Hour of the Night, as before.

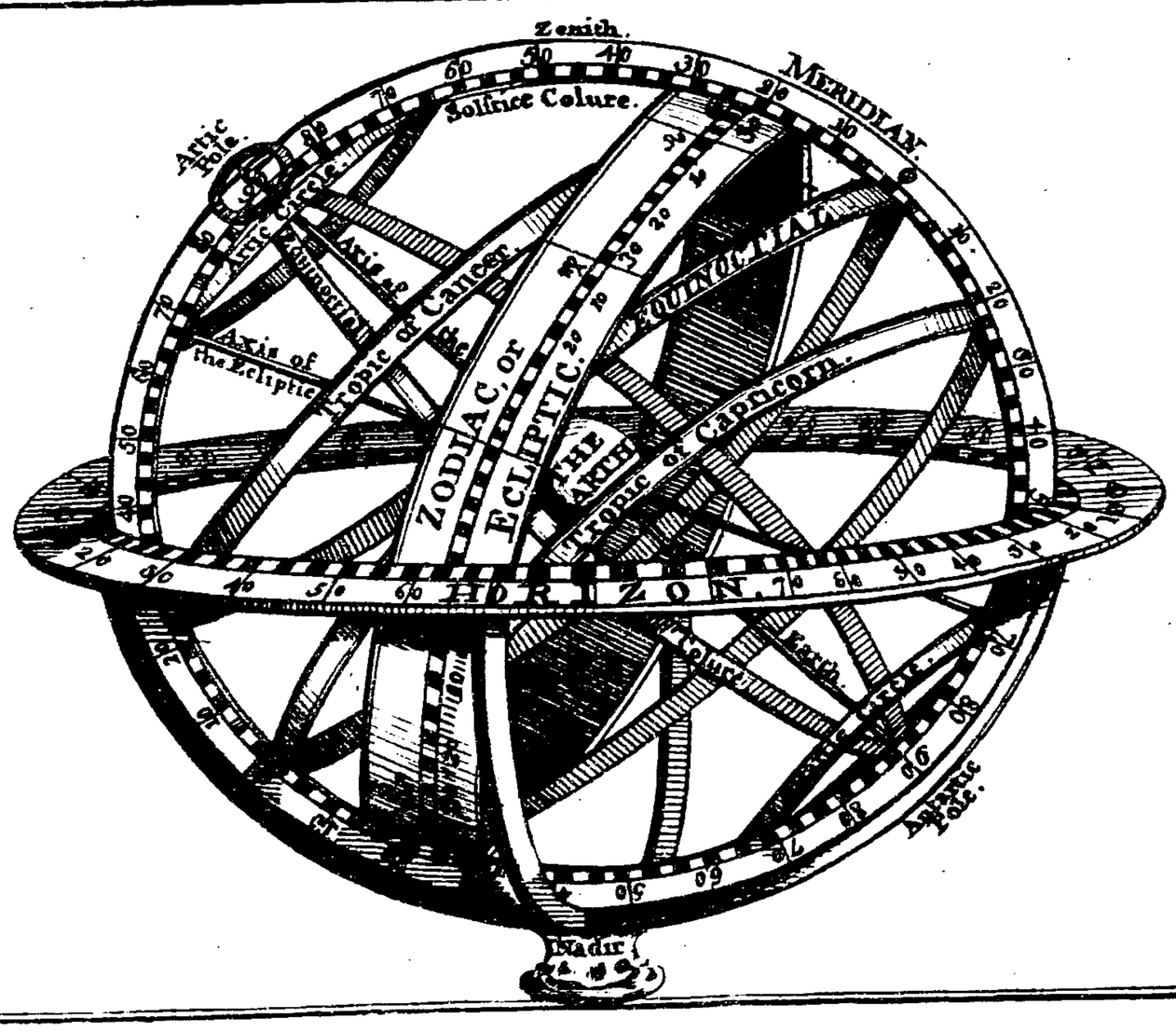
By this Inſtrument you may tell, at any Time, by Day or by Night, the Situation of thoſe Stars when they are not viſible, by Reaſon of the Sun's ſuperior Light, or Clouds: For, having ſet the Day of the Month to the Hour, by your Watch, hold up the Book with its Back towards the North, (as in the laſt Example) and then the Stars upon the Clock will correſpond with thoſe in the Heavens, and point their Places there.

Thus, on the 23d of *Auguſt*, at 1 o'Clock in the Afternoon; I find the *Great Bear* full South; the two bright Stars in the Middle of his Back, call'd the *Pointers*, are upon the upper Part of the Meridian; the other two bright Stars, with the three in his Tail, lie a little to the Eaſt.——The *Little Bear*, and the *Dragon's Head*, full Eaſt.——*Cephus* and *Caſſiopeia*, near the Meridian, below the Pole.——And *Auriga*, full Weſt.

☞ This Clock will anſwer, at all Times, theſe *Problems* on this Side the *Equator*: But for thoſe Places beyond it, in *South Latitude*, the *Conſtellations* round the *South Pole* ſhould be inſerted; and, in making the Obſervations, the Book ſhould be held up, and turn'd towards the *South Pole*.

THE

THE CŒLESTIAL GLOBE AND SPHERE.



THE DESCRIPTION AND USE OF THE CÆLESTIAL GLOBE.

THE *Cæleſtial Globe* is an *artificial Sphere*, on whoſe Surface the *fix'd Stars* are placed, at proportionable Diſtances from each other, juſt as they are in the Heavens; together with the principal Circles of the *Sphere*.—The *Uſe* of this curious Inſtrument is to point out the various Motions and Appearances of the *Sun*, *Moon*, *Planets*, and *Stars*, in an eaſy and natural Manner, without having Recourſe to long and tedious Calculations.

The better to determine the Places of the Heavenly Bodies, the ſeveral Circles which are deſcrib'd on the *Terreſtrial Globe*, are imagin'd to be transferr'd to the Heavens, and delineated among the Stars, exactly over thoſe Circles conceiv'd to be drawn on the Earth.——Thus, oppoſite the two *Poles* of the Earth are the two *Poles* in the Heavens; being the two places where the Earth's *Axis* (if continued thither) would ſeem to terminate among the Stars.—Over the *Equator* on the Earth runs the *Equinoctial* in the Heavens:—At 23½ Degrees on the North Side runs the *Tropic of Cancer*, and at 23½ South runs the *Tropic of Capricorn*.—At the ſame Diſtance from the *Poles* are the two *Polar Circles*, exactly over thoſe on the Earth.—Beſides theſe Circles, there is an *oblique one* going from one Tropic to another, cutting the Equinoctial in two oppoſite Places. This Circle is call'd the ECLIPTIC; and is that Path which the Earth would ſeem to deſcribe among the Stars, in one Revolution, if it was beheld from the Sun. It is divided into 12 equal Parts, and each of theſe into 30 more, correſponding to the 12 Months of the Year; which 12 Parts are ſometimes call'd the 12 *Signs*, from the Signs or Pictures drawn upon the Stars there *.

Their *Names* and *Characters* are here expreſs'd.

Aries ♈, *Taurus* ♉, *Gemini* ♊, *Cancer* ♋, *Leo* ♌, *Virgo* ♍,
Libra ♎, *Scorpio* ♏, *Sagitarius* ♐, *Capricorn* ♑, *Aquarius* ♒, *Piſces* ♓.

The firſt *ſix* are call'd *Northern Signs*, as lying on the North Side of the Equator, and the laſt *ſix Southern Signs*, becauſe they lye on the South Side the Equator.—On this Circle are found the *Sun's*, *Moon's*, and *Planets* Places; that is, under what *Degree* of any of theſe 12 Signs or Conſtellations they appear to be on any Day at Noon.

* Sometimes theſe Circles are cut out, and put together in form of Rings, interſecting each other as they do in the Heavens, with a little Earth on the Axis in the Center: This ſerves to give a better Idea of the Poſition of each Circle than a long verbal Deſcription would do. Their Names and Situations are expreſs'd in the Figure under the Globe.

The

The Globe, thus delineated *, is affix'd by its Poles to a *Braſs Meridian*, graduated into four Quadrants, as that of the Terreſtrial Globe is; *(i. e.)* on the upper Part from the Equator to the Poles; but on the under Part from the Poles to the Equator; and is then ſet in a *Wood Horizon*, on which are inſcrib'd the 12 *Months*, and the 12 *Signs* of the *Zodiac*, the ſeveral Degrees of which being plac'd againſt the Days of the Month on which the Sun is found in that Part of the Heavens; and the 32 *Points* of the *Compaſs*. —To compleat the whole, there is added a *Quadrant of Altitude*, to be ſcrew'd on occaſionally to the Top of the Meridian. Alſo an *Hour Circle* round the North Pole, and an *Index*.

The Globe being thus fitted up, and the Learner having acquainted himſelf with the Poſition and Diviſion of the ſeveral Circles and Conſtellations upon it, he may proceed, with Eaſe and Pleaſure, to the Solution of the following

PROBLEMS.

PROBLEM I. To find the *Sun's Place* in the *Ecliptic*.

Look the Day of the Month on the *Horizon*, and againſt it you have the *Sign* and *Degree* of the *Ecliptic* the Sun is in that Day: Then look the ſame Sign and Degree on the *Ecliptic Line* on the Globe, and there fix on a little *black Patch*, which will repreſent the Sun's true Place, and ſhew what Stars are round him that Day.

Thus, on the 24th of *May*, the Sun is in $3\frac{1}{2}$ Degrees of *Gemini*, or the *Twins*:—Is ſituate near the *Bull's Eye* and the *Seven Stars*, which are not viſible by Reaſon of his ſuperior Light. But was the Sun to ſuffer a total Eclipſe on that Day, you would then ſee thoſe Stars ſhining near him very bright †.

PROBLEM II. To find the *Sun's Declination*.

Having found the Sun's Place, (as in the laſt Problem) bring it to the *Braſs Meridian*; and the Degree which ſtands over it, ſhows the *Sun's Declination*, or Diſtance from the Equator, either *Northwards* or *Southwards* at that Time.

Thus, on the 24th of *May*, you will find the Sun to have 21 Degrees of *North Declination*: But on the 12th of *December*, he is found to have $23\frac{1}{4}$ Degrees of *South Declination*.

* The *convex* Surface of the Globe correſponds with the *concave* Surface of the Heavens; whence it is eaſy to conceive, that, if *Holes* were made in each Star, and an *Eye* plac'd in the Center of the Globe, it would view, thro' thoſe Holes, the ſame Stars in the Heavens repreſented by them.

† The Heavens are ſtudded over with *Stars* as much by *Day* as by *Night*, only the greater Light of the *Sun* renders them inviſible to us. But when that Luminary deſcends below the Horizon they begin gradually to appear. When the Sun is gone down about 12 Degrees, Stars of the firſt Magnitude become viſible. When he is 13 Degrees below the Horizon, thoſe of the ſecond Magnitude are ſeen. When 14 Degrees, Stars of the third Magnitude appear. When 15 Degrees, thoſe of the fourth Magnitude preſent themſelves to view. When he is deſcended 16, 17, and 18 Degrees, Stars of the fifth and ſixth Magnitude, with thoſe of the ſmalleſt Size become conſpicuous, and the azure Arch ſparkles with all its Glory.

PROBLEM III. To *rectify the Globe*, or to adjuſt it ſo to the Place where you are, as it may repreſent the preſent State or Situation of the Heavens.

Raiſe the Pole, till it ſtands as many Degrees above the Horizon as is the Latitude of the Place you are in: which may be done by the Degrees mark'd on the lower Side of the Meridian, and number'd from the Pole: Fix the Quadrant of Altitude on the Meridian to the Zenith; that is, on the Top to the Latitude of the Place: Turn the Globe, by the Help of a Compaſs, till the Pole points to the real Pole of the World: Bring the *Sun's* Place in the *Ecliptic* to the Meridian, and ſet the Index to the upper 12; ſo will the Globe exhibit the Face of the Heavens for the Noon of that Day, at the Place you rectified the Globe for. And by turning the Globe till the Index points to any given Hour, you will ſee the Situation of the Heavens there at that Hour.

☞ If the Place be in *North Latitude*, the *North Pole* muſt be rais'd above the Horizon; if in *South Latitude*, the *South Pole* muſt be rais'd.

PROBLEM IV. To find the Time of the *Sun's Riſing* and *Setting*; and alſo his *Amplitude*, or Diſtance from the *Eaſt* or *Weſt* Points of the Horizon, at the Times of his Riſing and Setting; and the Length of the *Day* and *Night*.

The Pole being elevated to the Latitude of the Place where you are, bring the *Sun*'s Place in the *Ecliptic* to the Braſs *Meridian*, and ſet the Index at the Pole to 12, or Noon: Then bring down the Sun's Place to the *Eaſtern* Side of the Horizon, and the Number of Degrees between the *Eaſt Point* and the *Point* where the Sun is, is the *Amplitude* at *Riſing*. The Hour pointed to by the Index on the Dial-plate, is the Time of the *Sun's Riſing*.—The Sun's Place brought to the *Weſtern* Edge of the Horizon, ſhows there, in like Manner, the Amplitude at *Setting*; and the Index points out the Time of the *Sun's Setting*

☞ The Time of the *Sun's Riſing* being *doubled* gives the Length of the *Night*: And the Time of his *Setting* being *doubled* gives the Length of the *Day*, or the Time he appears above our Horizon.

Thus, on the 24th of *May*, at *London*, the Sun riſes at 4, with 36 Degrees of *Eaſtern Amplitude* (*i. e.* 36 Degrees from the Eaſt to the North); and ſets at 8, with 36 Degrees of *Weſtern Amplitude*; making the Day 16 Hours long, and the Night 8 Hours.——The Sun now riſes upon the North-Eaſt by Eaſt Point of the *Compaſs*, and ſets upon the North-Weſt by Weſt Point.

PROBLEM V. To find the Beginning and End of *Twilight*.

Rectify the Globe; turn it *Weſtward*, with the Quadrant of Altitude, (which muſt be ſcrew'd on the Meridian to the Latitude of the Place) till the *Point oppoſite* the Sun's Place in the *Ecliptic* cuts the Quadrant at 18 Degrees above the Horizon; the Index will then ſhew the Time *Twilight begins* in the Morning.—The ſame *Point*, brought with the Quadrant of Altitude to the *Eaſtern* Side the Globe, till it cuts the 18th Degree, as before, the Index will then point the Time when *Twilight ends* in the Evening *.

Thus, on the 24th of *May*, you will find the Point in the Ecliptic oppoſite the Sun's Place, (which is $3\frac{1}{2}$ Degrees of *Sagitarius)* will not reach the 18th Degree in the Quadrant of Altitude, which ſhows that the *Sun* does not deſcend, at that Time, 18 Degrees below the Horizon; conſequently, we have then *no Night*, but a *continued Twilight*.——But, on the 12th of *December*, *Twilight* begins about Half paſt 5, and ends about Half paſt 6. And on the 21ſt of *March*, and 23d of *September*, *Twilight* begins about 4 in the Morning, and ends about 8 at Night.

PROBLEM VI. To find the *Azimuth* and *Altitude* of the *Sun* at any Time of the Day.

The Globe being rectified, and the Quadrant of Altitude ſcrew'd on the Braſs Meridian at the Latitude of the Place where you are, bring the Sun's Place to the Meridian, and ſet the Index to 12: Then turn the Globe, till the Index points the Hour given, and lay the Quadrant to the Sun's Place; ſo will the Degree of the Quadrant lying upon the Sun, be his *Altitude* above the Horizon: And the Number of Degrees counted on the Horizon from the South Point to the Point where the End of the Quadrant cuts it, will be his *Azimuth* at that Time.

Thus, on *May* 24, at 9 o'Clock in the Morning, you will find the Sun to have about 44 Degrees of *Altitude* above the Horizon; and $62\frac{1}{2}$ of *Azimuth* from the South. And at 6 in the Evening of the ſame Day, his *Altitude* is 20 Degrees, and *Azimuth* 79 Degrees, ſo that the Sun is then upon the Weſt by North Point of the *Compaſs*.

* *Twilight* is that faint Light we have in a Morning before the Sun riſes, and in the Evening after the Sun is ſet. This is found, by Obſervation, to begin when the Sun comes within 18 Degrees of the Horizon in the Eaſt, and to end when he is gone 18 Degrees below the Horizon in the Weſt.——In the Southern Parts of *England*, the Inhabitants have no *real Night*, but a *Twilight*, from the 20th of *May* to the 22d of *July*.

PROBLEM VII. To find the *Oblique Aſcenſion*—*Right Aſcenſion*—and *Oblique Deſcenſion* of the *Sun*.

The Globe being rectify'd, and the Sun's Place brought to the *Eaſtern* Side of the Horizon; the Number of Degrees accounted from the Beginning of *Aries* to that Degree of the Equator now come to the Horizon, is the Sun's *Oblique Aſcenſion*. The Sun's Place being brought to the Meridian, the Degree of the Equator lying under it is his *Right Aſcenſion*. And, by bringing the Sun's Place to the *Weſtern* Side of the Horizon, the Degree then of the Equator in the Horizon, is his *Oblique Deſcenſion*.

Thus, on the 24th of *May*, (the Sun being in $3\frac{1}{2}$ Degrees of *Gemini*) his *Oblique Aſcenſion* will be found to be 32 Degrees—his *Right Aſcenſion* 62 Degrees—and his *Oblique Deſcenſion* 91 Degrees.

☞ The Difference in Degrees between the *Right* and *Oblique Aſcenſion* turn'd into Time, by allowing 15 Degrees for every Hour, ſhows how much the Sun (at that Time) riſes before or after 6 o'Clock. This is call'd the *Aſcenſional Difference*; which Difference is to be *added* to 6 in the *Summer Half-year*, but *ſubtracted* from 6 in the *Winter Half*, to give the Time of the *Sun's Riſing*.——In the above *Example*, the *Aſcenſional Difference* is 30 Degrees (which in Time is 2 Hours) to be *added* to 6; conſequently, the Sun roſe that Morning at 4, and ſet at 8.

PROBLEM VIII. To find the *Right Aſcenſion* and *Declination* of any *Star* repreſented on the Globe

Bring the *Star* to the Braſs Meridian; obſerve the Degree which ſtands over it, for that is the *Declination*: and the Degree of the Equator which comes to the Meridian with the *Star* is its *Right Aſcenſion*.

Thus you will find the *Declination* of *Aldebaran*, in *Taurus*, to be about 16 Degrees *North*; and the *Right Aſcenſion* about 65 Degrees.—And, in like Manner, the *Declination* of *Syrius*, or the *Great Dog*, to be about $16\frac{1}{2}$ Degrees *South*; and the *Right Aſcenſion* about 98 Degrees.

☞ The *Right Aſcenſion* and *Declination* of the *Sun* alter every Day; but the *Right Aſcenſion* and *Declination* of the *fix'd Stars* continue the ſame throughout the Year.

PROBLEM

PROBLEM IX. To find the *Longitude* and *Latitude* of a *Star* or *Planet*.

Apply the End of the Degrees of the Quadrant of Altitude to that Pole of the Ecliptic which lies on the ſame Side the Ecliptic with the *Star*, and bring its graduated Edge to the *Star*, ſo will the Degree of the Quadrant at the *Star* point its *Latitude* reckon'd from the Ecliptic towards its Pole: And the Degree of the Ecliptic cut by the Quadrant, at that Time, will be the *Longitude* ſought.

Thus, the *Latitude* of *Capella*, or the *Goat*, in the Left Shoulder of *Auriga*, is about 22½ Degrees *North*, and *Longitude* about 19 Degrees in *Gemini*.—— And the *Latitude* of *Fomalhaut*, in the *Southern Fiſh*, is about 21 Degrees *South*, and *Longitude* 29½ Degrees in *Aquarius*.

☞ The *Latitude* of a Star is its Diſtance in Degrees and Minutes, counted from the Ecliptic Line towards its Pole.—If the Star lies on the North Side the Ecliptic, it has *North Latitude*; if on the South Side, it has *South Latitude*.

☞ The *Longitude* of a Star is its Diſtance from (the Equinoctial Point) *Aries*, reckon'd in Signs, Degrees, and Minutes.—If a Star is ſituate on the North Side the Ecliptic, you muſt apply the Quadrant to the North Pole of the Ecliptic, but if on the South Side, you muſt apply the Quadrant to the South Pole of the Ecliptic, as was done in the above Example of *Fomalhaut*.

PROBLEM X. To find the *Oblique Aſcenſion* and *Olique Deſcenſion* of any *Star*.

Elevate the Globe to the Latitude of the Place where you are; then bring the *Star* to the Eaſtern Side of the Horizon; and the Degree of the Equator then cut by the Horizon is the *Oblique Aſcenſion*: Turn the Star to the Weſtern Side, and the Degree of the Equator cut by the Horizon is the Star's *Oblique Deſcenſion*.

Thus at *London* you will find the *Oblique Aſcenſion* of *Aldebaran*, or the *Bull's Eye*, to be about 43½ Degrees; and the *Oblique Deſcenſion* about 87 Degrees, ——In like Manner, the *Oblique Aſcenſion* of *Syrius*, or the *Great Dog*, will be found to be about 121 Degrees, and the *Oblique Deſcenſion* about 75 Degrees.

☞ The *Sun*'s and *Planets Oblique Aſcenſion* and *Deſcenſion* differ every Day in the ſame Latitude, but a *fix'd Star's Oblique Aſcenſion* and *Deſcenſion* are every Day the ſame all the Year.

PROBLEM XI. To find the *Riſing*, *Southing*, and *Setting* of any *Star*, together with its *Continuance* above the Horizon.

Rectify the Globe for the Place where you are; bring the Sun's Place to the Meridian, and ſet the Index to the upper 12: This being done, bring the *Star* you enquire after to the *Eaſtern Side* of the Horizon; and the Index will ſhew the Hour of its *Riſing*.—Turn it on to the Meridian, you have (by the Index) the Time of its *Southing*.—And, by bringing it to the *Weſtern* Side of the Horizon, the Time of its *Setting*.——The *Hours* on the *Dial-plate* from the *Riſing* to *Setting*, ſhow the *Continuance* of the *Star* above the Horizon, and the remaining *Hours*, the Time the *Star* is *below*, or under the Horizon.

Thus, on *May* 24, at *London*, the Star *Aldebaran*, or the *Bull's Eye*, will be found to *riſe* about three Quarters paſt 4 in the *Morning*; will come to the *Meridian* about *Noon*; and *ſet* about three Quarters paſt 7 in the *Evening*. It therefore continues above the Horizon 15 Hours, and below it 9 Hours.

☞ This *Star* is not viſible at that Seaſon of the Year, by Reaſon of its Nearneſs to the *Sun*.——But, on the 24th of *November*, at *London*, *Aldebaran* will riſe about three Quarters paſt 4 in the *Evening*, and ſet about three Quarters paſt 7 in the *Morning*; ſo that he will be then viſible *all Night*, if the Sky continues clear.

PROBLEM XII. To find the *Eaſtern* and *Weſtern Amplitude* of a *Star*.

The Globe being rectify'd, as before, and the Star brought to the *Eaſtern* Side of the Horizon, you have, upon the Horizon, the *Amplitude*, i. e. the Diſtance in Degrees from the *Eaſt*, either Northward or Southward; and alſo, the Point of the *Compaſs* the Star riſes upon. Turn the Star to the *Weſt* Side, and the Horizon ſhews the *Amplitude* and Point it ſets upon there.

Thus, on the 24th of *May*, at *London*, *Aldebaran* will have about $25\frac{1}{2}$ Degrees of *Amplitude* from the *Eaſt* towards the North at *Riſing*; and about $25\frac{1}{2}$ Degrees of *Amplitude* from the *Weſt* towards the North at *Setting*.——He *riſes* nearly Eaſt-North-Eaſt, and *ſets* nearly Weſt-North-Weſt.

☞ The *Stars*, though they *riſe* at different Hours of the Day, yet always *riſe* on the *ſame Point of the Compaſs*.

PROBLEM XIII. To find the *Altitude* and *Azimuth* of a Star at any Hour.

The Globe being rectify'd, and the Quadrant of Altitude ſcrew'd on the Meridian at the Latitude where you are: Bring the Sun's Place to the Meridian, ſet the Index to 12, and turn the Globe till the Index Points the Hour given: Then by laying the Edge of the Quadrant upon the *Star*, you find (by the Degree againſt it) the *Altitude* above the Horizon at that Time; and the End of the Quadrant will ſhew, upon the Horizon, the *Azimuth* of the Star, and alſo, the Point of the *Compaſs* it then bears upon from you.

Thus, at *London*, on *November* 24, at 9 at *Night*, you will find, (by proceeding as above) that *Aldebaran* will have about 36½ Degrees of *Altitude*; with 68 Degrees of *Azimuth* from the South; and that he bears upon the Eaſt-South-Eaſt Point of the *Compaſs*.—But, at 3 in the *Morning*, he will have about 41 Degrees of *Altitude*; about 59 Degrees of *Azimuth*; and bear upon the South-Weſt by Weſt Point of the *Compaſs*, nearly.

PROBLEM XIV. The *Altitude* of the *Sun* by Day, or of any *Star* by Night, being given, to find the *Hour* of the *Day* or *Night*.

Rectify the Globe to the Place where you are; fix on the Quadrant of Altitude to the Meridian at the Latitude given; bring the Sun's Place, at that Time, to the Meridian, and ſet the Index to 12. This done, turn the Globe and the Quadrant together, till the *Star*, or the Degree of the Ecliptic the *Sun* is then in, cuts the Quadrant in the *Altitude* given; the Index will then point the Hour ſought.

Thus, on *May* 24, at *London*, when the Sun is obſerv'd to be about 44 Degrees *high*, in the *Morning*, you will find the Time to be 9 o'Clock. And when his *Altitude* is 20 Degrees, in the *Afternoon*, you will find it to be 6 at Night.—Alſo, on *November* 24th, at *Night*, *Aldebaran* being obſerv'd to be about 36½ Degrees *high*, and to the Eaſt of the Meridian, we find (by proceeding as before) that it was 9 o'Clock when that Obſervation was made.

PROBLEM XV. To meaſure the *Diſtance*, in *Degrees*, between any *two Stars*.

Lay the Beginning of the Quadrant of Altitude upon *one* of the *Stars*; apply the graduated Edge to the *other*; and the Degrees contain'd between the *Stars* are their Diſtance requir'd.

Thus the Diſtance between *Aldebaran* and *Capella* will be found to be 30 Degrees. And the Diſtance from *Syrius* (the *Great Dog*) to *Deneb* (the *Lion's Tail*) 81 Degrees.

☞ The ſame might have been done with a Pair of Dividers; for opening from one Star to another, and applying the Wideneſs to the *Equinoctial*, the Degrees between the Legs is the Diſtance, as before. If the Quadrant is not long enough to reach from one Star to the other at once, you may meaſure the Diſtance at twice.

PROBLEM XVI. To find what *Stars* never *riſe* nor *ſet* to the Inhabitants of any given Place.

All thoſe *Stars* towards the *North Pole*, which lie not further from it than the *Zenith*, or Complement of the Latitude of the Place, never *ſet* at that Place.——And all thoſe *Stars* which lie at the ſame Diſtance from the *South Pole* never *riſe*, or appear above the Horizon of that Place.

Thus, at *London*, if you elevate the Pole to the Latitude of 51½ Degrees, you will ſee, by turning the Globe round, that all the Stars from that Latitude to the North Pole, as the *Great Bear*, *Little Bear*, *Draco*, *Cephus*, and *Caſſiopeia*, never *ſet*, or deſcend below the Horizon.——As alſo, that thoſe Stars ſituate at the ſame Diſtance from the South Pole, as *Hydrus*, *Toucan*, *Indus*, *Pavo*, *South Triangle*, *Muſca*, *Croſiers*, *Piſces volans*, &c. never aſcend above the Horizon of *London*, but remain ever inviſible to the Inhabitants there.

☞ Hence it is eaſy to conceive, that the Inhabitants at the *North Pole* can never ſee any of the Stars lying South of the Equinoctial; nor can the Inhabitants at the *South Pole* ſee any Stars lying North of the Equinoctial. But thoſe who *inhabit at the Equinoctial* will have the Pleaſure of ſeeing all the Stars from Pole to Pole.

PROBLEM XVII. To *diſtinguiſh* the *Stars* in the *Heavens* one from another, and to know them by their proper Names.

Rectify the Globe to the Latitude of the Place where you are; bring the Sun's Place to the Meridian, and ſet the Index to 12: Then turn the Globe to the *given Hour*, and there let it remain; ſo will every Star inſcrib'd upon it exactly correſpond with, and point to the ſame Star in the Heavens; and by transferring the Eye from the Globe to the Stars, you will evidently diſcover the ſame there *,

Thus, on the 24th of *November*, at 10 at Night, (the Globe being rectify'd, and plac'd, by means of a *Compaſs*, *North* and *South*) you will immediately perceive the *North Pole* of the Globe point to a *Star* of the *ſecond Magnitude*, which is the *Pole-ſtar*; round which all the reſt circulate every 24 Hours.—At the ſame Time you may obſerve, a little lower, *two Stars*, not quite ſo *bright* as the *Pole-ſtar*, almoſt in a Right-Line with it, and *four* more which form a Kind of *Quadrangle*: Theſe ſeven make the Conſtellation call'd the *Little Bear*, the *Pole-ſtar* being in the End of the *Tail*.——Near the ſame Place, but more towards the *Eaſt*, you may obſerve ſeven bright Stars, all of the ſecond Magnitude, which are commonly call'd *Charles's Wain*, but by *Aſtronomers* the *Great Bear*; the two foremoſt of the Square lie almoſt in a Right-line with the *Pole-ſtar*, and are called the *Guards*, or *Pointers*; ſo that

* If a Right Line be imagin'd to proceed from the Center of the Globe, (when rectify'd) through any Star on its Surface, that Line will fall upon the ſame Star in the Heavens, and point it out, if continued thither.

knowing

knowing the *Pointers*, you may eaſily find the *Pole-ſtar*.———Further on, almoſt *Eaſt*, and near the Horizon, is ſeen a bright Star of the firſt Magnitude, call'd *Procyon*, or the *Little Dog*.———Higher up the Sky, and a little more to the *North*, you find two bright Stars in *Gemini*, or the *Twins*,; the uppermoſt is of the firſt Magnitude, call'd *Caſtor*, the other of the ſecond Magnitude, and call'd *Pollux*.———Higher, ſtill towards the Zenith, you ſee the brilliant Star *Capella*, or the *Goat*, in the Shoulder of *Auriga*; this is of the firſt Magnitude. ———Lower down, and nearly *South-Eaſt*, you obſerve *Aldebaran*, or the *Bull's Eye*, a Star of the firſt Magnitude, and near that the *Pleiades*, or noted *Seven Stars* (all ſmall ones) in the Back of the *Bull*.———Between *Taurus*, or the *Bull*, and the Horizon, is ſeen the glorious Conſtellation *Orion*, with two bright Stars of the firſt Magnitude; one in his Right Shoulder, call'd *Bed-elgueze*, the other in his Left Heel, call'd *Regel*: In the Middle of this Conſtellation are three Stars of the ſecond Magnitude in a Right-line, and a little lower, three others of the third Magnitude, lying alſo in a ſtrait Line with each other; which Stars, by the *Country People*, are call'd the *Ell* and the *Yard*, but by *Aſtronomers*, *Orion's Belt* and *Sword*.

In this Manner the reſt of the Stars, in any other Conſtellation may be readily found, by obſerving how they lie with reſpect to thoſe already known. A little Practice will make you well acquainted with them all.

☞ Between the *Bull's Eye* and the *Seven Stars*, you obſerve a large Star of a heavy dull Colour; but upon the Globe you don't find any, in that Place, correſponding with it. This ſhews that Star to be one of the *Planets*; and, by looking into Mr. *White's Ephemeris*, you will perceive it muſt be *Saturn*: For, *Saturn*, at that Time, is in about 2 Degrees of *Gemini*, with about 2 Degrees of *South Latitude*, which Situation exactly agrees with that Part of the Heavens where you ſee him.

PROBLEM XVIII. To find all thoſe *Stars*, which at any Hour, are *Riſing*, *Setting*, or upon the *Meridian*.

Having rectify'd the Globe, as in the laſt Problem, turn it till the Index points the given Hour: The Globe being kept in that Poſition, all thoſe Stars in the *Eaſtern Edge* of the Horizon are then *Riſing*, thoſe under the *Braſs Meridian* are upon the *Meridian* in the Heavens; and thoſe on the *Weſtern Edge* of the Horizon are *ſetting*.

Thus, on the 24th of *November*, at 10 at Night, we find *Charles's Heart*, the *Lion's Head*, and *Syrius*, or the *Great Dog*, *riſing*.— The *Little Bear*, *Perſeus*, the *Ram*, and *Whale*, *upon*, or *near* the *Meridian*.--- And *Aquarius*, or *Water-bearer*, the *Eagle*, *Hercules*, &c. *ſetting*.

PROBLEM

PROBLEM XIX. To find the *Place* of any *Planet* upon the Globe; and, by that Means, its true Situation in the Heavens.

First, by ſome *Ephemeris*, (Mr. *White*'s is one of the beſt) which has the *Planets Places* calculated to every Day at Noon, find the *Longitude* and *Latitude* of that *Planet*: Then make a Mark with a Pencil, or ſtick a little black Patch in that Point on the Globe, which Point will ſhow its true Situation, with reſpect to the *Stars*, and alſo what *Stars* immediately *accompany* it.

Thus, *November* 24, 1765, I find, by Mr. *White's Ephemeris*, that *Saturn* is in *about* 2 Degrees of *Gemini*, with a little more than 2 Degrees of *South Latitude*, at which Place I fix on a little black Patch repreſenting his Situation in the Heavens.—The ſame Day, I find *Jupiter* to be *in* 22¼ Degrees of *Leo*, with three Quarters of a Degree of *North Latitude*, where I ſtick on another Patch, for his true Place.—In like Manner you may ſet on little Patches repreſenting all the *Planets*, which will ſhew you their true Places at that Time, and how they are ſituate with reſpect to the *Stars*, and to one another.

PROBLEM XX. To find when any of the *Planets riſe* or *ſet*, or come to the *Meridian*; as alſo, the Point of the *Compaſs* they *riſe* or *ſet* upon.

Rectify the Globe to the Latitude where you are; bring the Sun's Place to the Meridian, and ſet the Index to the upper 12, and the Globe will exhibit the exact Situation of the Heavens at *Noon* that Day. Then bring the *little Mark* repreſenting the *Planet* to the *Eaſtern Side* of the Horizon, and the Index will point the Hour of its *Riſing*: Turning it on to the *Meridian*, you will ſee the Time of its *Southing*: And bringing it down to the *Weſtern Side*, you ſee the Index point the Hour of its *Setting*.

Thus, *November* 24, 1765, *Saturn riſes* nearly North-Eaſt by Eaſt, about a Quarter paſt 4 in the *Evening*;—comes to the *Meridian*, or *ſouths* about *Midnight*;—and *ſets*, nearly North-Weſt by Weſt, about Half paſt 7 next Morning. ——— *Jupiter riſes*, Eaſt-North-Eaſt, about a Quarter paſt 10 at *Night*;—comes to the *Meridian* at Half paſt 5 next *Morning*;—and *ſets*, Weſt-North-Weſt, at 1 in the *Afternoon*. After this Manner, may the *Riſing*, *Setting*, &c. of the reſt of the *Planets* be found.

☞ The *Azimuth*, *Altitude*, and *Declination* of the *Planets*, and alſo their *Amplitudes* at Riſing and Setting, are found in the ſame Manner as thoſe of the *Sun* and *Stars* delivered in the foregoing *Problems*.

PROBLEM XXI. To find the Courſe of a *Comet*, and alſo the Poſition and Direction of its *Tail* in the Heavens; with its *Riſing*, *Setting*, *Amplitude*, *Azimuth*, &c. at the Time whilſt it continues in our Part of the *Syſtem*.

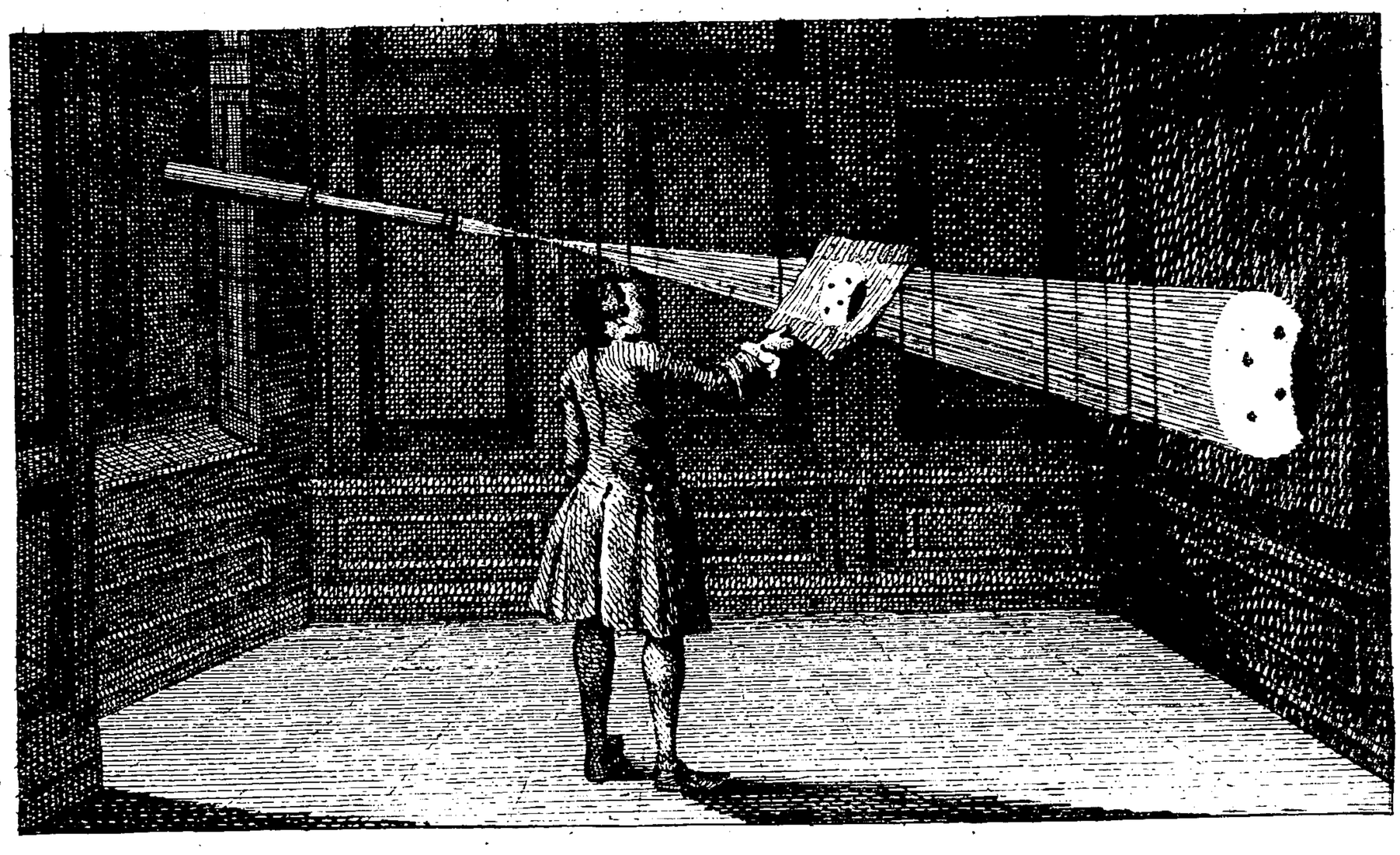
When a *Comet* is ſeen in our Hemiſphere, obſerve its exact Situation with reſpect to the Stars about it, and likewiſe the Form and Length of its *Tail*, and ſtick a ſmall Piece of Paper upon that Part of the Globe, cut into like Form with the *Comet*. Do ſo for *two* or *three* Nights ſucceſſively, and ſet on like Patches, repreſenting his Place at each Obſervation. By this Means you will diſcover its Courſe, which will be always in a great *Circle*, nearly: For, a *Thread* laid over theſe *Patches*, round the Globe, will exhibit the Tract it takes in the Heavens, and the Conſtellations it paſſes through.—Where the Thread cuts the *Ecliptic Line* will be the Place of its *Nodes*.

Now, if the Globe be rectify'd for the Day you make the Obſervation; the Sun's Place brought to the Meridian, and the Index ſet to 12; you may find the Time of the *Comet's Riſing* or *Setting*, by bringing it to the *Eaſtern* and *Weſtern* Side of the Horizon.——You may alſo find its *Azimuth*, *Amplitude*, *Altitude*, *Longitude*, *Latitude*, &c. (Poſition of its *Tail* with reſpect to the Horizon, at any Hour) in the ſame Manner as directed before for the *Stars*.

TO

TO MAKE CURIOUS OBSERVATIONS UPON THE SUN, MOON, and ECLIPSES, In a DARKENED ROOM.

THE Room you make Choice of for Experiments of this Kind, muſt have a Window in it, which opens towards the Object you would obſerve: Let it alſo be made quite *dark*, by means of a Shutter plac'd before the Window. Then affix the *Object-end* of a *Teleſcope* of about 4 or 5 Feet in Length into a Hole made in the Shutter; draw out the other End to its uſual Length, and turn it about till the Sun's Rays, paſſing thro' the Glaſs, fall upon a Sheet of white Paper held a little beyond the *Focus*, and you will have repreſented on the Paper, the exact Image of the *Sun*, as it really is in the Heavens, with the *Spots* diſtinct upon his Face at that Time, as appears in the Figure below.



If the Paper be remov'd further from the Glaſs, the Image will increaſe its Dimenſions: And it may be ſo contriv'd, as to fall on the oppoſite Wall, (if it be cover'd with any thing white) where the Image will be magnified ſeveral *Feet*, and the *Spots* an *Inch*, or more, in Diameter.

The *Moon*, likewiſe, may be exhibited in this Manner, but her Light is rather too faint to render the *Spots* very diſtinct.

But, by this Method, an *Eclipſe* of the *Sun* is ſeen to the greateſt Advantage; For, without any Hurt or Uneaſineſs to the Eye, you behold the whole *Phænomenon* of the *Eclipſe*.—How it *begins*, and where it *ends*;—in what Manner the *Moon* paſſes over the *Sun's Diſk*;—with the *Quantity eclips'd* at every Moment, which is a moſt agreeable and delightful Appearance.

ASTRONOMICAL PARADOXES.

HAVING at the End of our *View of the Earth* inſerted a few Propoſitions (which are generally call'd *Paradoxes*, from the Surpriſe or Fallacy they ſeem to carry with them at firſt Sight) purely to recall the Attention of the *young Geographer* to a Reflection on what he has been peruſing; we have here added a few more for the Exerciſe of the *young Aſtronomer*; the Solution of which may be deduc'd from the Nature and Conſideration of the *Syſtem*, deliver'd in the foregoing Pages.

PARADOX I. There are ſeveral Places upon the Globe of Earth, where the *Sun* and *Moon*, and all the *Planets* do actually *riſe* and *ſet* according to their various Motions, but never any of the *fix'd Stars*.

SOLUTION. Under the *Poles*.—The *Planets* by their Revolutions in their Orbits are ſometimes *North* and ſometimes *South* of the Equinoctial Line; conſequently, riſe and ſet as the *Sun* does, with reſpect to thoſe Places. But the *fix'd Stars* keeping an exact Diſtance from the Poles, may be ſaid never to riſe or ſet, but continually move round them.

☞ The Motion which the fix'd Stars have upon the Poles of the Ecliptic, being ſo very ſlow as to make no viſible Alteration in their Places for Ages, cannot be any Objection to this Paradox.

PARADOX II. There is a very remarkable Place upon our Globe, where all the *Planets*, notwithſtanding their different Motions and various Aſpects, do all bear upon the ſame *Point* of the *Compaſs*.

SOLUTION. Under either of the *Poles*.—For to an Eye at the *North Pole* all the Stars, however ſituate, will bear upon the *South Point*: And, at the *South Pole*, they will, on the contrary, bear on the *North Point* of the Compaſs; becauſe every Point of the Compaſs becomes a *Meridian*, as obſerv'd in Paradox I. in my *Geography*.

☞ For the ſameReaſon, and at the ſame Places, a *Full-moon*, which is always oppoſite the Sun, may both happen to riſe and ſet at the ſame Inſtant of Time, and upon the ſame Point of the Compaſs.

PARADOX III. There is a certain Place in the Iſland of *Great Britain*, where the *Stars* are always *viſible*, (at any Time of the Day) if the Sky be not overcaſt with Clouds.

SOLUTION. The Place may be ſome deep Pit or Well; or Profeſſor *Maſkeline*'s Obſervatory, at *Greenwich*; ſuch alſo as *Tycho Brahe* had at *Denmark*, which was a deep Well beſet with Glaſſes, where he ſat and obſerved the *Stars* at all Seaſons.

PARADOX IV. There is a certain Iſland near the Continent of *Europe*, ſome of whoſe Inhabitants are of ſuch exquiſite Sight, that even with *one* of their Eyes, they can actually behold 10 *Moons*, real and true, all at once above the Horizon; and alſo *ten Times* the Number of Stars beheld by others with both their Eyes at the ſame Inſtant.

SOLUTION. Any Iſland, or other Place; provided the Obſerver is furniſh'd with a good *Teleſcope*, which will ſhow the 5 *Moons* of *Saturn*, the 4 of *Jupiter*, and our own *Moon*; all which are 10 in Number. Alſo, they will ſee thro' the Glaſs, 10 Stars for 1 beheld by the naked Eyes. Nay, in the *Milky Way*, where we can't behold even one Star, they will ſee an infinite Number, ſo cloſe and thick together, that their united, though faint Light cauſes that Whitiſhneſs, which gives it the Denomination of the *Milky Way*, before mentioned.

PARADOX V. To ſeveral Parts of the Globe, there are ſeveral *Planets* which are ſo far from coming to an *Oppoſition*, that they form neither *Square*, *Trine*, nor *Sextile Aſpect* with the *Sun*.

SOLUTION. *Venus* and *Mercury*, whoſe Orbs are contain'd within the Orbit of our Earth, never form any of theſe Aſpects with the Sun.

PARADOX VI. There are ſeveral *Planets* ſaid to be in *Conjunction* with the Sun, not only when they appear in the *ſame* Degree of their Orbit with the Sun, but when they are in that Degree of their Orbit *diametrically* oppoſite to the former.

SOLUTION. The ſeveral Planets are *Venus* and *Mercury*, who have a *twofold* Conjunction with the Sun; one in the *ſuperior*, and another in the *inferior*, or oppoſite Point of their Orbits. In the inferior Conjunction they paſs like *Spots* between the Sun and us; but in the ſuperior Conjunction they paſs behind the Sun, leaving him between us and them.

PARADOX VII. There is *one* certain Place in the *Univerſe*, where the *Planets*, both inferior and ſuperior, may be conſtantly ſeen to move forwards, in the ſame regular and uniform Manner, though, to moſt Places of the Earth, they appear (at the ſame Time) to move very unequally; and, ſometimes, they ſeem to *run back*; and, at other Times, *not to move at all*.

SOLUTION. At the *Sun*, the Center of the Syſtem, the Planets move all regular and direct according to the Order of the Signs: But to us, out of the Center of their Orbits, they appear ſometimes *direct*, ſometimes *ſtationary*, and ſometimes *retrograde*.

PARADOX VIII. Tho' the Number of Stars in a clear *Winter Night* ſeem almoſt *infinite*; and Mr. *Flamſtead* (late Aſtronomer Royal) has given us a *Catalogue* of 3000: yet it is difficult for the moſt penetrating Eye to reckon, at any Time, above 100.

SOLUTION. This Appearance is only a Deception of the Sight, ariſing from their vehement Twinkling, whilſt we look on them confuſedly, and without reducing them to order. For, when we come to view them more diſtinctly, we find the confus'd Number vaniſh, and we can ſeldom number more than in the whole Heavens.

☞ Tho' the Number of Stars which can be ſeen by the naked Eye are ſo *few*, yet it is probable there are many more beyond the Reach of our Sight. For, through *good Teleſcopes*, they appear in vaſt Multitudes in every Part of the Heavens; and the better the Glaſſes are the more are ſtill diſcovered. The learned Dr. *Hook* has obſerv'd 78 Stars in the *Pleiades*, of which the naked Eye cannot diſcern more than 6. And in *Orion*, which has but 80 Stars in the *Britiſh* Catalogue, there has been counted more than 2000.

PARADOX IX. There is a certain place upon the Earth, above whoſe Horizon *Saturn* is 15 Years together; and there is another Place, of conſiderable Diſtance from the former, which has *Jupiter* nearly 6 Years above their Horizon, without once ſetting during that Time.

SOLUTION. This Place is under or near the *Poles*, where *Saturn* continues without ſetting all the Time he is in that Half of his Orbit, North of the Equinoctial, which is about 15 Years, his Period being 30 Years. The other Place, at a conſiderable Diſtance, is the *South Pole*, where *Jupiter* muſt continue viſible through that Part of his Orbit South of the Equinoctial, which is about 6 Years; his Period being 12 Years nearly.

PARADOX X. There are ſeveral *Planets*, or *wandering Stars*, which at certain Times *appear* and *diſappear*, whoſe Light decreaſes as they come *towards* the Earth, and increaſes as they go *from* the Earth; and ſo *tranſparent* are they, that the *ſmalleſt Star* can be ſeen through them.—There are, alſo, others, ſo *opaque*, that in Conjunction with the Sun they appear as *Spots* on his *Face*; and the *farther* they are from us, the *bigger* they ſeem.

SOLUTION. The firſt Part of this Paradox reſpects the *Comets*, which wander through all the Orbs of the *Planets*, and to vaſt Diſtances beyond *Saturn*, where they become inviſible. Theſe wonderful Bodies *decreaſe* in their Light as they come towards the Earth, (if they paſs between us and the Sun) and *increaſe* as they go from it, by turning more of their illuminated Side towards us. Thro' their amazing Tails, which are ſo very rare and thin, Stars of the ſmalleſt Magnitude may be ſeen. The other *opaque Planets*, which appear as *Spots* on the Sun's Face, are *Venus* and *Mercury*, in their inferior Conjunctions, paſſing between us and the Sun. And the *Moon*, every one knows, appears much bigger in the *Horizon* than in the *Meridian*, though, in the latter Situation, ſhe is about 4000 Miles nearer us than in the former.

☞ This *Deception* is owing to the *Refraction* of the *Atmoſphere*, as obſerv'd in one of the Paradoxes of my *Geography*.

To theſe Paradoxes Numbers might be added, but they would ſwell the Book beyond the Dimenſions of a *Compendium*, as well as (perhaps) tire the Youth in the Peruſal. I ſhall therefore only beg Leave to detain him, whilſt I offer to his Attention an *Obſervation* on the beautiful and pious Exclamation of royal *David* on viewing the Heavens.

When I behold (ſays he) *the* MOON *and the* STARS *that Thou haſt ordained*, full of various Beings, whoſe Nature and Conſtitutions are admirably adapted to the World Thou haſt plac'd them in; who have ſtill, perhaps, retain'd their original Innocence and Purity; whoſe Hearts are now warm with Reflections on thy Goodneſs, and whoſe Tongues are telling forth thy Praiſes: *Lord, what is Man!*—Man, who has ſo often broken thy Laws, and ungratefully diſregarded thy holy Statutes, that *Thou art mindful of him!*—That thou doſt continue him ſtill in Exiſtence, and furniſh him ſo liberally with every Bleſſing of Life!—*Or what is the Son of Man*, the poor Inhabitant of this ſmall Corner of thy infinite Creation, *that Thou ſo regardeſt him!*—That Thou haſt, in ſuch a ſingular Manner, procur'd him a REDEEMER, who has ſo happily deliver'd *him* from the Miſeries juſtly due to his *Ingratitude*, and confer'd on him *Immortality* and *Glory* for ever.

*** The Learner having carefully gone over this Syſtem, will read Dr. *Keil's Lectures*, Dr. *Young's Aſtronomy*, and Mr. *Martin's Young Lady's and Gentleman's Philoſophy* with a peculiar Pleaſure.

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